ENGINEERING AND MINING JOURNAL

JULY, 1941

...meet the record demand for copper, smelters are being pushed to capacity. Above, the stacks of A. S. & R.'s Garfield plant

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In this issue

The Pirquitas Tin-Silver Enterprise in Argentina
Rosiclare Fluorspar Installs New Electric Power Plant
Industrial Relations at Climax • Rock Pressures Underground
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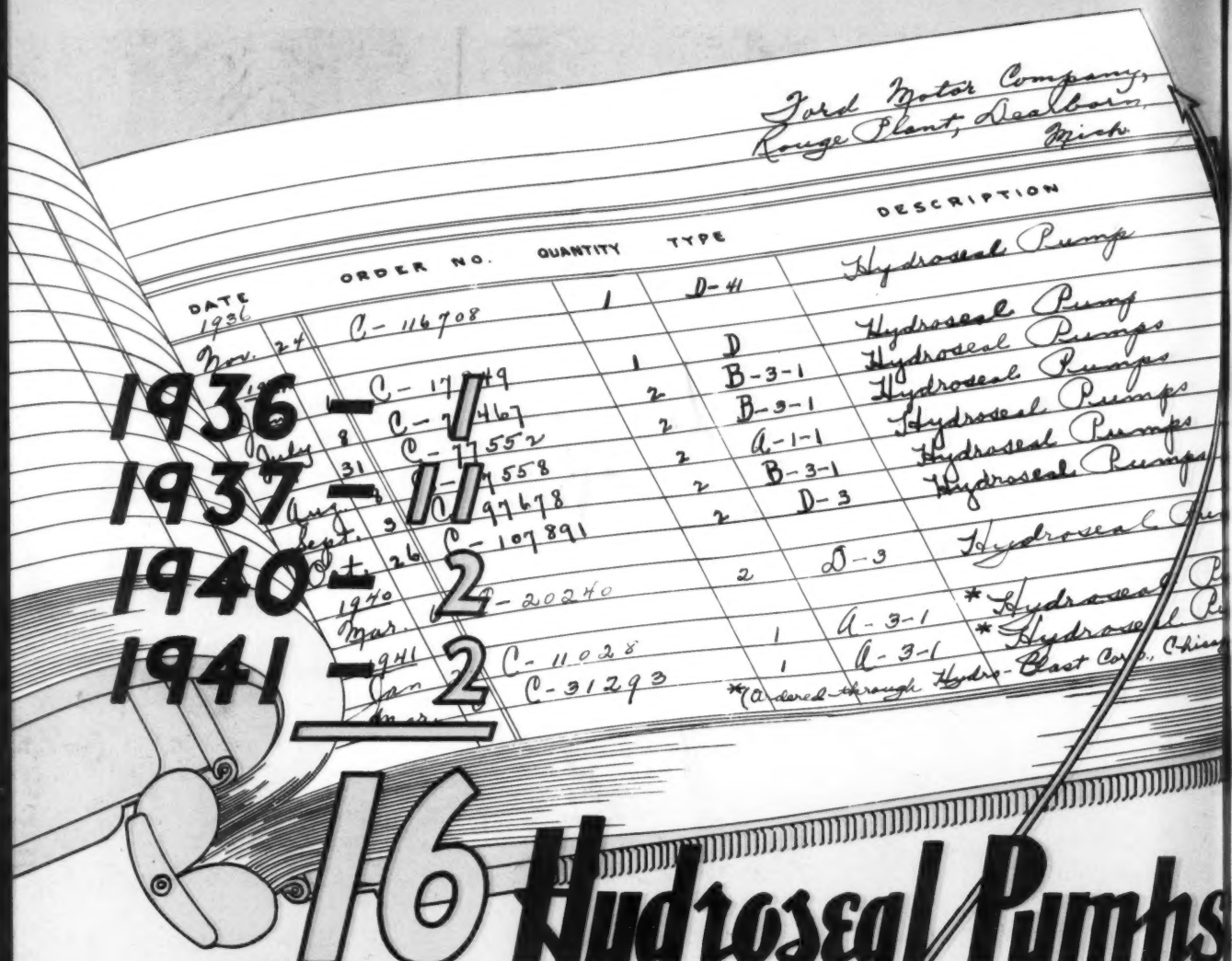

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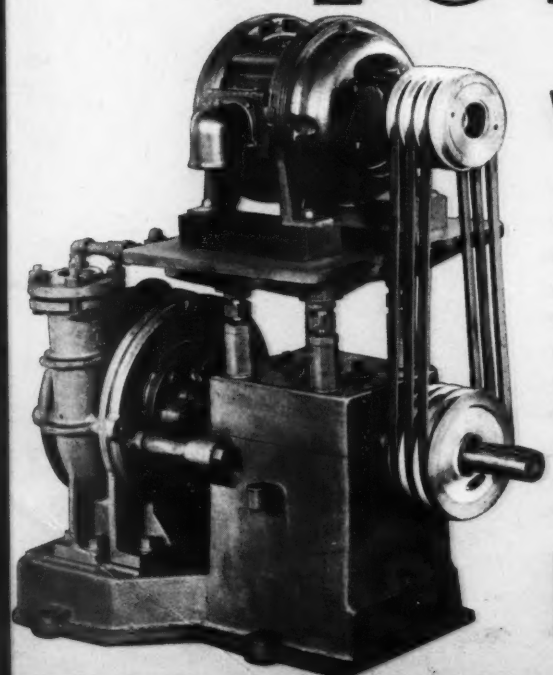

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DIAMOND JUBILEE NEXT MONTH

After months of planning and preparation, the editors present next month the 75th Anniversary Number of *E.&M.J.* It will be notable not only for the absence of long, dry, historical reviews, but for a constructive effort to look at the future of the mining industry. The issue will contain two features: First, a series of 25 or 30 one-page vignettes, each dealing with a single aspect of mining and metallurgy; second, a series of thumbnail sketches of the mineral resources of the Western Hemisphere from Pole to Pole. Our authors have made a commendable effort to look into the future, and we believe that our 75th birthday will be fitly celebrated by a genuine contribution to progress in the mining industry. Things to come, rather than past events, will be emphasized for your edification and profit. Although we are 75 this year, we don't feel that old, and we look forward with pleasant anticipation to the next 75 years of service to the mining industry.

H. C. PARMELEE
Editor

ENGINEERING AND MINING JOURNAL

H. W. CLARKE
Vice-President

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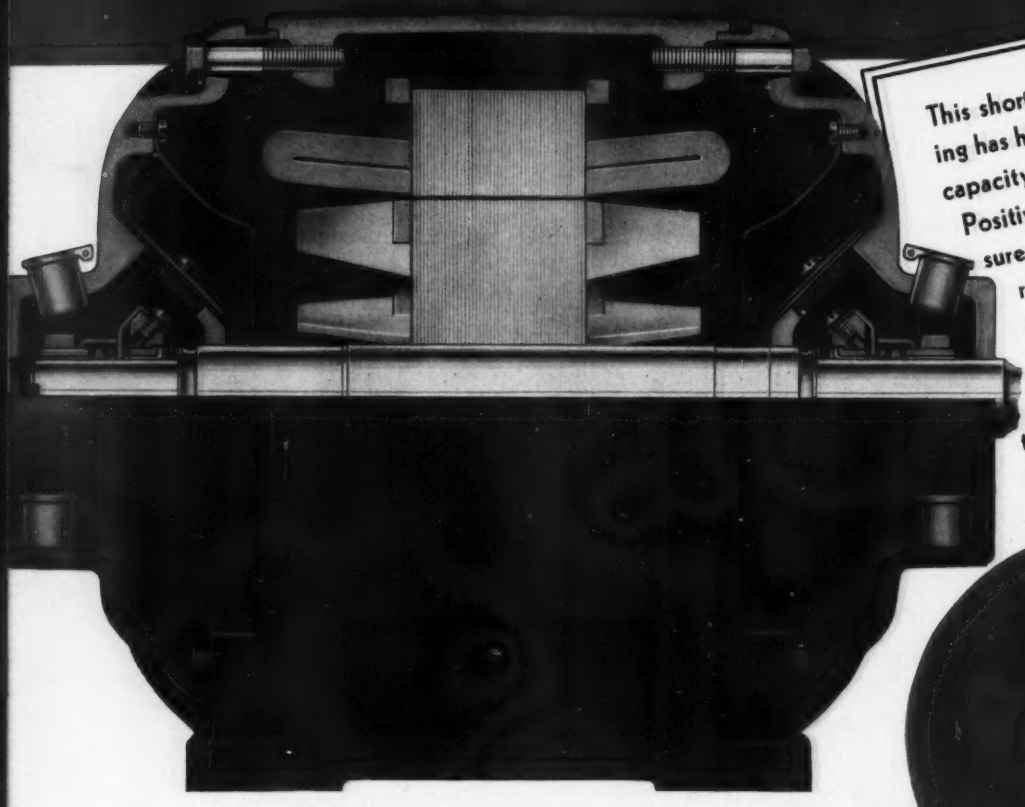

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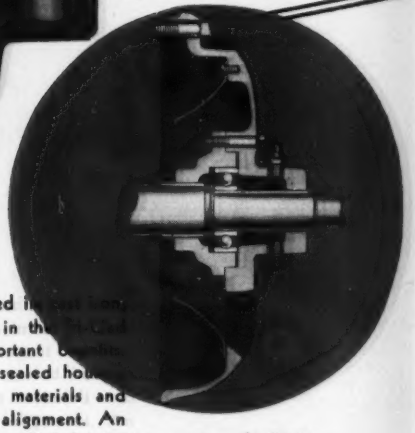

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Volume 142 JULY, 1941 Number 7

Diamond Jubilee Number

NEXT MONTH the editors will present a special number of *E.&M.J.* in celebration of the 75th anniversary of the founding of the *Journal*. The issue will mark the culmination of more than a year of thinking and planning, in the course of which many ideas and proposals were considered and abandoned. The one that finally crystallized represents an attempt to contribute something constructive to the future mining industry of the Western Hemisphere.

Two features will mark the Diamond Jubilee Number: First, a series of vignettes on future technology in mining and ore treatment; second, a collection of thumbnail sketches of the mineral resources of the Western Hemisphere from Pole to Pole. Neither feature will be characterized by long, dry historical reviews; both will be forward-looking, brief, and to the point. Progressive engineers will discuss future trends in the unit operations of exploration, mining, mineral dressing, and metallurgy. Others will marshall the array of mineral resources in the Western Hemisphere that will make for solidarity and defense of the Americas. Both themes are timely and have been capably treated by more than threescore authors. Their ideas will merit your attention.

Tell the Truth And Shame—the Senate

BOTH HOUSES OF CONGRESS have been investigating the national defense program, and committees have reported to their respective bodies. They disagree so radically in their findings that one wonders how two groups of men, presumably intelligent, could uncover such diametrically opposed "facts." We lean toward the views of the Military Affairs Committee of the House as being more reasonable and factual.

Senator Mead, of New York, submitted the report of the special committee of the Senate. It is a fine bit of demagoguery, and an affront to the intelligence of informed men. In order to account for the shortage of aluminum he makes a whipping boy of the Aluminum Company of America, and hails the Reynolds Metals Company as the savior of the country, all of which is nonsense. He assails the Office of Production Management as an incompetent body, subservient to its master's voice in industry. This is cheap politics, considering the Senator's lack of industrial experience. His voice will carry conviction when he can speak with the authority of a Knudsen. He discloses his abysmal ignorance of industrial production when he reports that, after the Government has furnished the power facilities and allowed private capital to amortize its investment over five years, there is no basis for large profits to private interests because *"management skill and services is all there is left."* Exactly. Would that there were comparable management skill and services in the New Deal.

The House committee report was more realistic about the reason for aluminum shortage. "It is obvious that neither the army, navy, or OPM could estimate their requirements, especially of aluminum, until they were aware of the numbers, designs, and sizes of planes to be constructed." What is true of aluminum is true of practically all raw materials. Nobody could possibly have foreseen what would be needed. Under the circumstances the hindsight of the Senate's special committee is a useless gift.

Opportunity and the Non-Metallics

GONE ARE THE DAYS when the producer of kaolin, or china clay, could successfully maintain that the grade of clay could not be controlled and that the only course open to users of his product was to compensate for its deficiencies. Today, in the Spruce Pine district of western North Carolina, there are plants in operation wherein up-to-date beneficiation technique is being applied and superior

products are being turned out. One of these is the ultra-modern plant of Kaolin, Incorporated, erected four years ago and now a steady producer of refined kaolin and, in addition, mica. Froth flotation serves for recovering the latter. The enterprise is notable on several counts. It is described elsewhere in this issue. Another outstanding plant in the same area is the Lunday unit of the Harris Clay Co. Very recent news is to the effect that the Harris company will also undertake the operation of the mine and plant of Kaolin, Incorporated, under lease.

For two decades the mining engineer whose attention was concentrated on the metals has been told at intervals that the non-metallic minerals offered opportunities that he would do well to note. Here we have convincing evidence that this has been very true. Research on the beneficiation of other non-metallics is also making progress and each year sees some new advance. The field is still attractive.

Metal Imports Necessary

DESPITE the well-known clash between defense officials and New Dealers at Washington, both groups are apparently agreed that the country is not yet alive to the meaning of an "all-out" program of national defense and aid to the warring democracies. The critical aspects of the situation filter through all too slowly to the masses of the people and even to some segments of industry. We doubt, however, if non-ferrous metal mining is open to that criticism. As producers of essential raw materials, mining men are aware of the magnitude of the job assigned to them. Indeed, they must wonder at times what becomes of all the metals they produce to meet an apparently insatiable and ever-growing demand.

Estimates of probable needs of raw materials for the defense program have now been raised to a point where large imports of non-ferrous metals are essential to supplement home production. Consequently, copper, lead, and zinc have been moving into the United States on an increasingly larger scale.

Copper is the prime example. During the first five months of the current year the United States produced duty-free refined copper at the annual rate of 1,108,000 tons, a noteworthy performance in a 12-cent market. Import statistics covering the first four months of the year show that intake of foreign metal in one form or another was at the rate of 635,000 tons a year. The Office of Production Management now estimates military and civilian requirements will amount to a minimum of 1,810,000 tons for the year.

Extraordinary measures have been and will continue to be taken to insure production of this quantity. Tariff barriers have already been nullified by Government purchases in Latin America; and the domestic price ceiling is about to be disregarded in order to stimulate production from high-cost areas at home. Through the Metals Reserve Company during four months ended June 30, the Government released to fabricators of defense material more than 150,000 tons of copper of foreign origin. This had been bought at 10 cents per pound, United States ports, and was distributed at 12 cents Connecticut Valley. Conversely, the Government is now preparing to pay in excess of 12 cents a pound for domestic copper costing more than that amount to produce, but may absorb the bonus and distribute the metal at the price fixed for large primary producers. Price is no longer a fixed factor, but a flexible means of getting production.

Domestic zinc production for the first five months of 1941 was at the rate of 738,900 tons a year. Estimated requirements for 1941 amount to 1,165,000 tons. Imports will have to play an important part in meeting the demand, although domestic production will rise as new smelting capacity comes in. Imports for the first four months of 1941 were at the rate of 220,100 tons of metal, of which about 200,000 tons consisted of zinc in concentrates originating in Latin America.

Output of lead refined in this country in the first five months of 1941 was at the annual rate of 706,500 tons. This total includes refined lead produced from foreign ore and entered for domestic consumption. Imports of lead as bullion and as refined pig lead during the first four months of 1941 were at the annual rate of 216,000 tons. Since the beginning of the year the demand for lead has been unusually active, and the industry now finds itself in a tight spot with reference to supplies.

Ocean shipping is the potential bottleneck to the importation of foreign non-ferrous metals and concentrates to supplement domestic production. In announcing the order that placed zinc under mandatory priority control, OPM made it clear that inability to get ships to move 450,000 tons of zinc concentrates, largely from Latin American countries, could reduce seriously the supply of zinc that smelters are expected to produce in 1941. Requirements for copper and lead also loom so large that the Government probably will find it necessary to provide shipping to maintain a steady flow of foreign metal into the United States.

Reflections from Washington

By Special Correspondent

SHORTAGES OF EVERYTHING plague Washington. Probably most serious from the standpoint of the mineral industries are prospective power shortages. If some Aladdin's lamp could be rubbed to provide at least a million kilowatts of new generating capacity, every kilowatt would be in demand immediately. This power situation has led to much controversy and recrimination in the Capital. This in itself would not be significant were it not really typical of the continuing distrust between various groups which must work together somehow if the defense programs are to advance.

Shortage of power in the T.V.A. area is one of the hottest subjects of this controversy. It lends itself to a continuance of the row of public-utility and public-ownership groups; and the backwash affects planning for metal production, particularly aluminum, magnesium, and copper refining. Latest guess of those who usually guess accurately is that great new publicly owned, and perhaps later publicly operated, metal plants will be established at Grand Coulee. If so, Mr. Ickes will have been supported in his favorite anti-monopoly program.

Other Shortages

MOST immediate in its general effect is the transport shortage, a problem of ships for movement of crude oil from Venezuela and the Gulf Coast to Eastern seaboard refineries. There is no doubt that some form of rationing or voluntary restriction of gasoline usage will be necessary for at least a quarter or a third of the population of the country. The way these problems are being handled by Petroleum Administrator Ickes is significant for the mining groups, because the pattern now being cut is likely to govern in subsequent commodity handling problems.

Labor shortages are frankly forecast by Army spokesmen. These relate to many works which are now being forced from five-shift or six-shift weeks up to as high as twenty-shift weeks in noncontinuous industry.

Shortage of containers for many types of goods is also anticipated. Early attempts at substitution for tin containers and certain other such forms has encountered secondary difficulties. The use of plastics, for example, is proving impractical in many cases because the shortage of plastics threatens to be almost as serious as the shortage of tin.

Government Monopoly

THE GOVERNMENT is taking complete control of many strategic materials by actual ownership. Rubber is the first commodity, but by no means the only one for which this drastic program will be applied. The initial step on rubber was taken when the government announced that all future imports would be made by Rubber Reserve Co. and that private imports would be prohibited.

Almost every other strategic material may be so handled soon, including tungsten, manganese, chromium, and surely tin. The technique contemplates speeding of stockpile building from imports as well as maintenance of controlled flow of rare strategic materials to defense industry.

The fact that the rubber companies have been told that they must gradually cut down rubber use from 99 per cent in July to 80 per cent in December indicates that manufacturing limits of drastic sort are going to be set in many fields.

New Magnesium Estimates

MAGNESIUM PRODUCTION capacity of 400,000,000 lb. annually is now recommended by OPM. This represents a multiplication of over ten-fold from the 1941 program. No one who has studied the plans intimately believes that the objective will be reached even by the end of 1942 unless extravagant and drastic measures are taken beyond the present admitted willingness of officials.

The Dow and the Permanente programs are to be expanded; that much is sure. Seven other companies working in the blueprint stage or on pilot plants are negotiating arrangements.

This expansion of the magnesium program far beyond the wildest estimates of three months ago indicates a bit of panic philosophy that is now found in numerous Washington centers. It is so easy to say "We *must* have . . . ". Thus many industrial programs previously moving forward rather sanely have been seriously disorganized by such actions.

Aluminum Criticism

A SPECIAL COMMITTEE of the U. S. Senate investigating the defense program makes the amazing discovery that the United States is not going to have as much aluminum next year as it would like to use in the manufacture of aircraft. The committee undertakes to place the blame for this discovery, which all of the rest of Washington apparently made anywhere from three months to a year ago.

The Truman committee blames OPM. Apparently it is not proper, in the committee judgment, for the government to depend on those who know the most about a subject. But the committee does not explain where more power or where other experienced people competent to build and operate aluminum plants are to be found. Impartial observers, if there are any such in this hot controversy, would probably conclude that the Congressional report was intended primarily for political consumption. But those same observers would also note that there is just enough truth in the claim that full dependence was placed on Alcoa to give probable wide credibility to the criticism.

When a complete breakdown of materials supplies occurs next year, as dispassionate calculation indicates that it surely will, there undoubtedly will be more such interpretations, criticizing industry for not multiplying its plants like guinea pigs. The fact that the Army's estimates of requirements on many of these commodities are not yet known in the middle of 1941 is not regarded as any excuse for failure to supply the materials.

If all the hot air released in Washington on these subjects could be put under a steam boiler, there would probably be a lot of new power available to offset the present energy shortage. But without this kind of controversy, Washington would not be its normal self.

Allocation of Civilian Supplies

THE MONTHLY REVISION of the priorities critical list was issued June 10. It recognized a status previously existent in official language as: "It will be noted that all metals except a few precious ones are now covered by this list." This means that concerns which want to buy equipment, machinery, or even parts for maintenance and repairs must often demonstrate the defense significance of their purchase before the metal becomes available for the equipment building or before the parts can be supplied through ordinary channels.

During June there was also announced a new policy for civilian allocation. This came out under the nominal definition of pig iron, ferro-alloy, and steel products regulation. However, the following plans stated categorically by OPACS are expected to apply to all metals. It should be understood, of course, that these allocation rules relate to the civilian supplies of those commodities which the priorities group of OPM says it can spare for activities not of a *direct* defense significance. Even if OPM commodity sections take over the job, the principles will stay as now.

"The following factors, among other relevant factors, are to be taken into consideration in making such allocations:

"a. The need to provide adequately for civilian uses essential to the public welfare.

"b. The degree of hardship upon labor or business resulting from the failure to obtain deliveries when scheduled or from the rejection of orders.

"c. The past rates of consumption of the products by users thereof.

"d. The objective of achieving an

equitable division of supplies of the products among all users.

"e. The availability of substitutes for the particular uses for which the products are sought.

"f. The policy of the Administrator to refuse allocation to any person who, in the conduct of his business, discriminates against defense orders."

To War Status

"THE PROBLEM of converting peace-time industries to war-time producers has far-reaching economic and social implications for management, workers, invested capital, as, indeed, for the national economy itself." This is an authorized portion of an address by a spokesman of Defense Contract Service of OPM. It represents a present willingness to admit that for all practical purposes (except trigger-pulling) the government is functioning on a full war basis.

There are several types of authority which the President and his principal aides do not have definitely under the law. It is frankly admitted about Washington that there is no place in the statutes where one can find an explicit authorization for the President to take over an aircraft plant, as he did the North American plant in California. Equally frankly there are made admissions that many of the price-fixing actions of OPACS and certain of the civilian allocation plans find no positive statutory authority.

But this does not preclude official action, nor is it likely that Congress will hesitate to give definite authority, nor the courts to support the government actions. Washington believes that public opinion has now adequately advanced to the point of support of full war-time authority.

The complete way in which readjustments will be worked in the other mineral industry has already been adequately demonstrated on metals.

The whole program is on the philosophy expressed by Secretary of War Stimson, "We face the possibility of a long war." And there is no doubt that everyone, including President Roosevelt, is willing to take any necessary action, no matter how drastic, to get speed-up.

Industry Committees

REORGANIZATION of OPM activity got a good start late in June. The new plan contemplates advisory committees for industry and commodity sections within OPM. The purpose is to give a one-stop service for the varied requirements of an industry which now must scatter its effort through production, priority, purchase, and civilian allocation units. The new set-up is a long step toward, but not quite enough to reach, the Baruch plan, which would imitate the 1917 War Industries Board.

For administrative supervision, each commodity section will be assigned to one of the present three major division chiefs of OPM. Thus steel, aluminum, and magnesium activities will be supervised by Production Director Biggers. The copper, zinc, and other nonferrous metal sections will be under Priorities Director Stettinius. As yet no metal or mineral units will work under Purchase Chief Nelson. It should be understood, however, that these administrative executives continue their old functional responsibilities, and have the new dual personality imposed merely for administrative reasons.

Representatives of civilian allocation of OPACS will be placed in the various commodity sections for cooperation with the industry committees. Thus there is virtually returned to OPM the job of placing goods which can be spared from the Defense program. Recently that function had been under OPACS Administrator Henderson. Henderson retains full responsibility for price control, but is relieved of much of the work, and some of the responsibility, for civilian allocation.

Depletion Allowance

A TREASURY DECISION of June 21 defines depletion allowances for tax purposes as follows: "If the number of recoverable units of mineral in the property has been previously estimated for the prior year or years, and if there has been no known change in the facts upon which the prior estimate was based, the number of recoverable units of mineral in the property as of the taxable year will be the number remaining from the prior estimate, but in any case in which it is ascertained either by the taxpayer or the Commissioner as the result of operations or development work prior to the close of the taxable year that the remaining recoverable mineral units as of the taxable year are materially greater or less than the number remaining from the prior estimate, then the estimate of the remaining recoverable units shall be revised and the annual depletion allowance with respect to the property for the taxable year and for subsequent taxable years will be based upon the revised estimate unless a change in the facts requires another revision. Such revised estimate will not, however, affect the basis for depletion."

Zinc Pacts

WHEN zinc was put under full priority control on June 11, it was provided that all defense needs after July 1 should be filled ahead of any civilian requirements. After defense needs have been met, there would be no difficulty about making deliveries to non-defense users, assuming any surplus. The following official summary of the situation shows, however, that any such surplus is highly improbable in the near future. Some diversion to very essential civilian activities must, therefore, be assumed as a later allocation job of OPACS. Here is the official summary:

"Available figures indicate that the total supply of zinc in 1941 will approximate from 890,000 to 950,000 short tons. The estimated requirements for 1941, however, including military and civilian needs, are now estimated at 1,165,000 short tons. This indicates an over-all shortage of from 215,000 to 275,000 tons for 1941.

"A factor involved in the shortage is that the total supply figures for 1941 include over 200,000 short tons which would be produced from foreign ores. However, approximately 450,000 tons of concentrates is required for this production, and any inability to get ships to move this tonnage from South America could reduce seriously the estimated supply for this year. Potential demand in cartridge brass as new cartridge facilities come in may intensify the existing tightness."

Priority for Makers of Mining Equipment and Supplies

REPAIR and maintenance materials and equipment required for uninterrupted operation of vital industries and public services were given a blanket form of priorities July 1 in a formal order from OPACS. The system is designed to provide essential articles ahead of all non-defense uses and ahead of allocation for defense production to the extent that this is possible. The program covers 26 industries, including mining and quarrying and metallurgical plants engaged in production of raw materials.

Applications for priority assistance under this program should be addressed to Edward R. Stettinius, Jr., OPM Director of Priorities. It is anticipated that standard forms will be prepared for use by industry in obtaining emergency allocation of required supplies. It is emphasized that the system shall be used only to obtain necessary materials and equipment to maintain operations. The order specifically states that the program shall not be used "to accumulate excessive inventories or to divert parts still serviceable."

News "Fines"

Wage-Hour Rules—In application of the Wage-Hour Division regulations in mining properties, it is increasingly evident that the Labor Department is making one important, and rather new, distinction. Any employee who assists the general business activity by sharpening tools, cooking meals, washing dishes, or rendering any service to the mining workers, is regarded as an employee subject to the Fair Labor Standards Act. But if the company incidentally runs a store, there may be circumstances under which the employees at the store may not be subject to the rules. One such circumstance would be that the store is merely maintained for the convenience of the workers in an isolated community and that it sells for cash or the equivalent of cash, on short-time credit, not only to the employees of the mine, but to anybody else who happens to want to get something there at the shop. Such an activity might under the retail store ruling be an intra-state activity even though the owner of the store were the mining company. If some of the business is wholesale, generally not exceeding one-quarter of the total dollar value of business, then it still could be a store of this classification. But if the store sells more than 25 percent at wholesale, the retail intra-state classification is lost. Generalizations on this subject are rather difficult, but this broad principle appears to be growing in acceptance for the classification of taxable and exempt workers.

THE PIRQUITAS MINE
A Tin-Silver Property in Argentina

Ross Field*
Kelseyville, Calif.

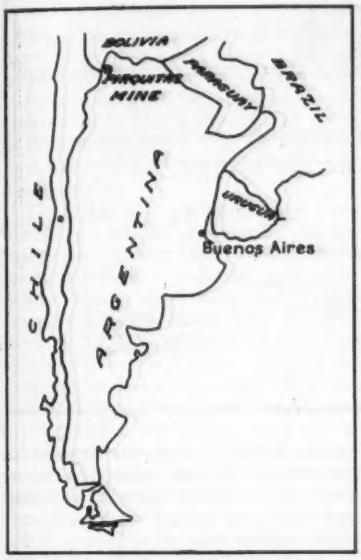

Fig. 1 . . . Location map

▶SCENE OF A *relatively new discovery of tin and silver in the Argentine, the property here described by Mr. Field is said to be the second mine in importance in the Republic. The article is presented with the idea that many will find it interesting, particularly in view of the fact that the question of tin supplies in the Western Hemisphere is just now in the limelight.*

PIRQUITAS MINE is owned by the Sociedad Minera Pirquitas, Picchetti y Cia., a company formed with limited liability under Argentine laws and with Argentine capital. It is situated in the extreme northwest corner of the Argentine on the southern extension of the Bolivian *altiplano*, and is in the Province of Jujuy, Department of Rinconada. The altitude of the workings ranges from 4,200 to 4,300 meters (13,778 to 14,108 ft.), the surrounding peaks rising to 5,700 meters (18,701 ft.).

An auto road 130 km. long connects the mine with the nearest station, Abra Pampa, on the Ferrocarril Central Norte Argentina, a State-owned railroad. This railroad in turn connects with Buenos Aires, from which port the company's concentrates are shipped.

Drainage is eastward through Pircas Creek to the Orosmayo River to the Pilcomayo, thence to the Paraguay and then to the Parana and the Atlantic Ocean. Climate is rigorous, rain and snow falling in the summer months from December to March. Annual precipitation is variable, furnishing barely enough water for operations. Vegetation is scarce, consisting largely of a hardy grass locally called *paja* and a low bush known as *tola*.

Along the Orosmayo River below the mine the Spaniards worked placer gold in the days of colonization. Near the beginning of the century attempts to mine for gold with a small dredge were made but abandoned. Up to 1930 the presence of tin was unknown in the region. In November and December, 1930, Alberto Picchetti found placer cassiterite in the Orosmayo while panning for gold. Following up the indications, the rich placer on Pircas Creek was discovered. Not until December 1934 were the outcrops of any of the veins, from which the placer had its origin, discovered in the canyon 4 to 5 km. above. In June, 1935, the first lot of vein ore was taken out. In April, 1936, actual production began from the veins. On Aug. 31, 1936, the Potosi vein was found, rich in both tin and silver.

The Placer—The tin placer is a narrow plain at the mouth of Pircas Creek where it widens out upon leaving the harder Cambrian-Silurian schists and reaches the softer Tertiary shales. The average width of the stream gravels is 500 meters and the longitudinal extent of the workable placer 3 km. The soft clay-shale bedrock is a favorable factor in cleaning. All tin in the placer is in the form of cassiterite. An accompanying photograph gives a general view of the placer.

In depth the gravel varies from 5 to 7 meters. Of this, on the average, 5.21 meters is low-grade overburden, which is removed by 1- and 2-cu.yd. Marion draglines. The remaining 1 to 1½ meters, consisting of workable gravel, is loaded by hand into 1-ton cars and hauled by diesel locomotives to the concentrator. Loading of the gravel is done at the rate of 6 tons per man-shift.

Average grade of gravel worked during the year July, 1938, to June, 1939, was 7.150 kg. per ton of concentrate containing 60.563 percent of fine tin. Stated in terms of fine tin, the grade is 4.33 kg. per ton. The grade for the fiscal year 1939-40 was 4.30 kg. of fine tin per ton.

Two concentrators are at the property. One was erected later than the other and is more completely equipped. It will be described. The other is now being dismantled. The flowsheet is, briefly, as follows: The cars dump on a rail grizzly having a 3-in. opening, all oversize going to waste. The undersize goes by a 16-in. conveyor to a double-deck 3x12-ft. Allis-Chalmers Aero-Vibe screen fitted with a 1-in. and a ⅝-in. screen. Here the gravel is washed, all plus-1-in. size going to waste and the minus-1-in. plus-⅝-in. going directly to two 3-compartment Harz-type jigs making a concentrate and a tailing. The minus-⅝-in. product goes to two 25-ft. Hancock jigs that make a semi-concentrate and a tailing, the ratio of concentration here being 1:1. Semi-concentrate from the Hancocks is elevated to two 3-compartment Harz jigs that make a concentrate and a tailing. The hutch product of the jigs is delivered by a 2-in. Wilfley pump to a Plat-O table making a concentrate and a tail. Ratio of concentration is 142:1. The plant treats 840 tons in 16 hours. As a byproduct about 1.5 kg. of gold is recovered monthly.

The Potosi vein has been stoped to surface, as seen in the upper right

* At the time of writing this article the author was mine superintendent for Sociedad Minera Pirquitas, Buenos Aires, Argentina.

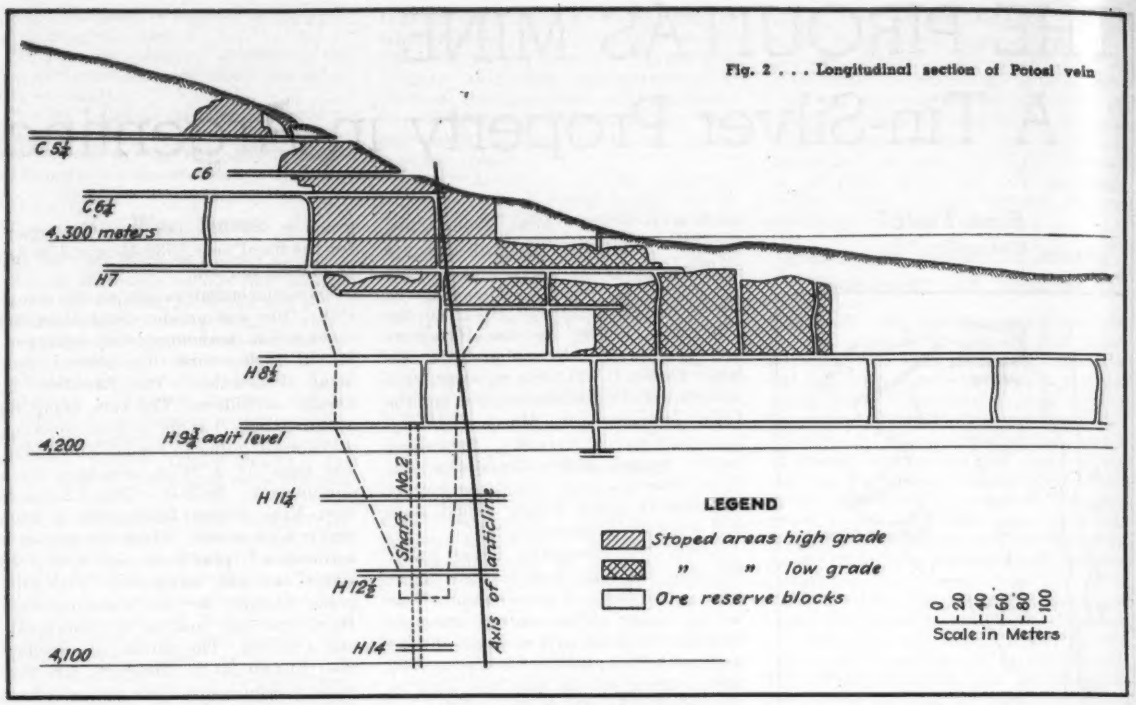

Fig. 2 . . . Longitudinal section of Potosi vein

Table I gives mill operation data for the past two fiscal years. Cost data are not available for publication.

Inasmuch as the high-grade, lower layer of the placer gravels is nearly worked out, plans have been made to work the lower-grade overburden by a dry-land portable concentrator to be fed by a 2-cu.yd. Marion dragline and a system of conveyor belts. This plant will treat 100 cubic meters per hour at a cost of 8c. Argentine per cubic meter. It will prolong the life of the placer at least four years and possibly longer by permitting the working of virgin ground not economically exploitable by the present method.

Electric power for all operations is generated at the property by two 450-hp. and one 150-hp. Crossley diesel engines. The current is generated at 380 v., 50 cycles, and transformed to 11,000 v. for transmission. The average consumption of diesel fuel oil is 300 grams per kilowatt-hour. Power cost for the year 1939-40 was 0.0722 pesos per kilowatt-hour.

The Veins—The country rock in which the veins are found is a sericite schist of Cambrian-Silurian age. It strikes from north-south to N. 10 deg. E. and is considerably folded. The original sediments were a series of interbedded quartz sandstones and shales, the shales predominating. The strata were of marine origin, although no identifiable fossils have been found in the immediate district. The series is overlain unconformably by Tertiary red beds of continental origin. These strata are made up of shales and volcanic ash, with an occasional sandy stratum, and at their base contain a typical basal conglomerate carrying angular fragments of the older series. The mineralization penetrates these younger strata.

In the immediate zone of mineralization no intrusive rocks are exposed at the surface. Fifteen kilometers north there is a volcanic cone of andesitic rock and at a similar distance to the south another cone of extrusive rocks. To the east 11 km. from the main veins is a small stock of quartz monzonite.

It is quite probable that beneath the mineralized zone and connected with the surrounding igneous rocks there is a cupola of intrusive material that gave origin to the mineralizing soltions. The age of mineralization is late Tertiary, corresponding to the Andean orogenic movements and period of intrusion. As will be shown later, the mineralization can be classed as epithermal.

The two veins are the Potosi and the Blanca. The Potosi strikes N. 65 to 80 deg. W. and dips from 80 deg. N. in its upper part to 70 deg. N. in its lower part. The vein averages 100 cm.

(approximately 4 in.) in width, varying from 50 to 250 cm. It is along a fracture caused by a small fault. The vein is a filling and in parts well banded. The Blanca vein strikes N. 45 deg. W., intersecting the Potosi, and dips 65 deg. S. It is also on a small fault fracture and carries considerable cemented breccia. Along both of these veins the pre-mineral movement was that of the north side moving west. Post-mineral movement has been noted but is small and unimportant.

Besides the main veins, many small, non-continuous veins filling joint cracks are found. The latter show a prominent wall-rock control in that they carry ore only in the sandstones and pinch out in the shales. These veins vary in width from 1 to 15 cm. The two main veins do not show this wall-rock control.

The following minerals have been identified: quartz, cassiterite, pyrite, sphalerite, galena, ruby silver, stannite, polybasite, andorite, and marcasite. These are given in approximate order of age, the oldest first. In addition, in the oxidized zone the following secondary minerals occur: cerargyrite, iron oxides and hydroxides, and native silver. Ruby silver is also found in the oxidized zone but may or may not be of secondary origin. One vein carries a barite gangue. The stannite is later than the ruby silver and, as stannite is generally considered to be of hypogene origin, this would indicate that the ruby silver is hypogene. The ruby silver is visible in the hand specimen as euhedral crystals in vugs in the pyrite and cassiterite. Important ore minerals are cassiterite, cerargyrite, pyrargyrite, and proustite. The cassiterite is fine-grained, light brown in color, and often intimately mixed with quartz. In the oxidized zone the cerargyrite is found in plates and also in fine dendritic masses of cubic crystals.

Oreshoots—The longitudinal section of the Potosi vein, Fig. 2, shows the two main oreshoots. The main high-grade shoot follows the west flank of an anticlinal fold in the sediments. It is believed that the anticline exerted an influence on the upward-moving mineralizing solutions tending to localize the shoot along the axis of the fold. The gently dipping Tertiary shales, now eroded, at one time lay only slightly above the tops of the present hills and may possibly have had a damming effect on upward-moving mineralizing solutions. Unfortunately the shoot is in the form of a V. Development has not yet disclosed whether another widening of the shoot will be found at greater depth.

To the east of the main oreshoot is a distinct shoot of much lower grade. This is workable only for its silver content in the zone of secondary enrichment. The sulphides below it contain only 0.88 kg. of silver per metric ton.

The oxidized part of the Potosi vein was very rich in secondary silver minerals, largely cerargyrite with some ruby silver. At the lower limit of oxidation some native silver was found. One stope on the C-6 level averaged 10 percent fine silver.

The tops of the main hills are cut

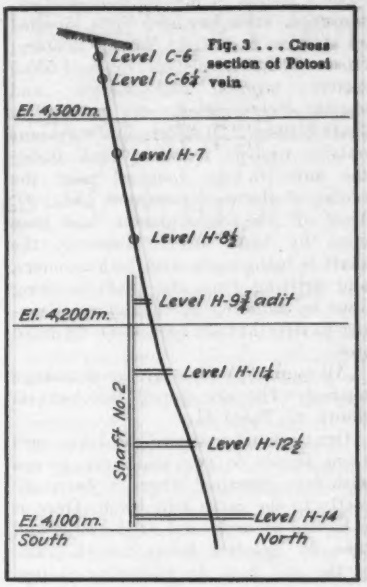

Fig. 3 . . . Cross section of Potosi vein

by an old age erosion surface. This long period of erosion undoubtedly accounts for the strong oxidation and for the resulting rich zone of secondary enrichment.

In the unoxidized portions of the Potosi vein the silver continues, decreasing from an average of 2.7 kg. per ton on the H-8½ level to 0.7 kg. per ton on the H-12½ level. Tin content in contrast continues downward in the shoot at practically the same percentage and ends abruptly.

The original discovery of practically all the veins has been made by following up surface float of the colored iron oxides. Early in the exploration program a total of 15,604 ft. of diamond drilling was done. This type of exploration did not prove entirely satisfactory because of irregularities of the veins and the spotty character of mineralization.

A large part of the development has been done by means of adits, as the hills rise to 300 meters above the main canyon. Since March, 1937, a total of

Table I—Concentration Plant, Operating Data, 1938–1939

	Metric Tons	Kg. Per Ton of Fine Tin	Tons of Fine Tin in Concentrate
Gravel treated	326,863.000	4.33	1,415.477
Concentrates produced	2,256.822	605.63	1,366.799
Tailing produced	324,606.178	0.15	48.678
	1939–1940		
Gravel treated	270,529.000	4.30	1,162.700
Concentrates produced	1,904.733	603.78	1,150.038
Tailing produced	268,624.267	0.05	12.662

Table II—Ore Stoped July 1, 1939, to June 30, 1940

Dry Metric Tons Ore	Percent Tin	Metric Tons Fine Tin	Kg. Silver Per Ton	Kg. Fine Silver
23,117	3.014	696.67	2.716	62.784

A general view of the Pirquitas placer

9,866.8 meters of development and exploration work has been done, divided as follows: drifts, 5,896.1 meters; crosscuts, 2,231.3 meters; raises, 1,555.9 meters; winzes, 24.5 meters; and shafts, 109.0 meters. At present, a shaft 3.40 by 2.10 meters in dimensions outside timbers is being sunk inside the mine in the footwall near the center of the main oreshoot (Fig. 3). Most of the development has been done by hand steel. However, the shaft is being sunk with jackhammers, and drifting from the shaft is being done by mounted jackhammers. Stoping to date has all been done by hand steel.

All stoping is done by the shrinkage method. The ore stoped last year is shown in Table II.

Ore is hand-trammed in ¾-ton cars from stopes to two main ore passes with 5-in. grizzlies, where it drops directly to the main adit level. Here it is hauled by mules out of the mine and then by gasoline locomotive 1.5 km. to the mill bin. In timbering stopes, local round hardwoods, quebracho and *palo amarillo,* are used.

The smaller non-continuous veins are worked on a tribute system, a graduated price being paid for the concentrate according to grade. For the year 1939–40 a total of 279,233 metric tons of concentrate containing 47.054 percent tin and 9.612 kg. silver per ton was so produced. The over-all duty per man-shift including surface crew for the year 1939–40 was 0.451 metric ton. Ore stoped by hand steel per man-shift was 3.285 metric tons.

To date all mining has been of oxide ore. Plans for changing milling procedure to deal with sulphides are being made.

Concentration of the Vein Ores—The milling is done in two plants. One, near the mine, makes a tin concentrate containing silver, the tailings being transported by truck 3.2 km. to a flotation plant, the principal concentrate of which is one of silver.

At the first-mentioned plant, known as the Tres Palcas plant, the minus-5-in. ore is weighed on a balance in the cars as received and a moisture sample is taken before dumping in a

Table III—Tres Palcas Mill 1939-1940

	Dry Metric Tons	Percent Tin	Metric Tons Fine Tin	Kg. Silver Per Ton	Kg. Fine Silver
Feed	24,395.361	2.816	686.901	2.365	57,704.129
Concentrate	554.235	39.505	218.948	14.698	8,146.016
Tailing	23,841.126	1.963	467.953	2.079	49,558.113

Table IV—Flotation Mill—Operating Data July 1, 1939, to June 30, 1940

Product	Dry Metric Tons	Percent Tin	Assays Kg. Ag. Per Ton	Content Fine Metal Tons Tin	Content Fine Metal Kg. Silver	Percent Tin	Distribution Silver
Feed	25,138.874	1.991	2.138	500.467	53,744.61	100.00	100.00
Table and jig concentrates	204.820	39.488	9.980	80.880	2,044.14	16.16	3.80
Silver concentrates	479.643	2.797	77.690	13.414	37,263.65	2.68	69.33
Tin concentrates from tables	129.285	42.252	1.753	54.625	226.65	10.91	0.42
Tailing	24,325.126	1.445	0.584	351.548	14,210.17	70.25	26.44

Table V—Total Production of Concentrates Since Discovery of Mine

Year	Wet Weight of Concentrate, Metric Tons	Content of Fine Tin in Metric Tons	Content of Fine Silver in Kg.
Before 1936	21.629	9.263	311.000
1936–37	1,463.718	353.719	42,735.734
1937–38	1,803.000	531.236	69,068.977
1938–39	1,408.278	344.368	74,119.953
1939–40	1,702.500	503.765	51,210.247
Total to June 30, 1940	6,399.125	1,742.351	237,445.911

The total silver production converted to fine ounces Troy is 7,634,052.

Table VI—Ore Reserves

Dry Metric Tons of Ore	Percent Tin	Kilos Silver Per Ton	Tons of Fine Tin	Kilos of Fine Silver
72,978	3.26	2.07	2,378.6	151,346

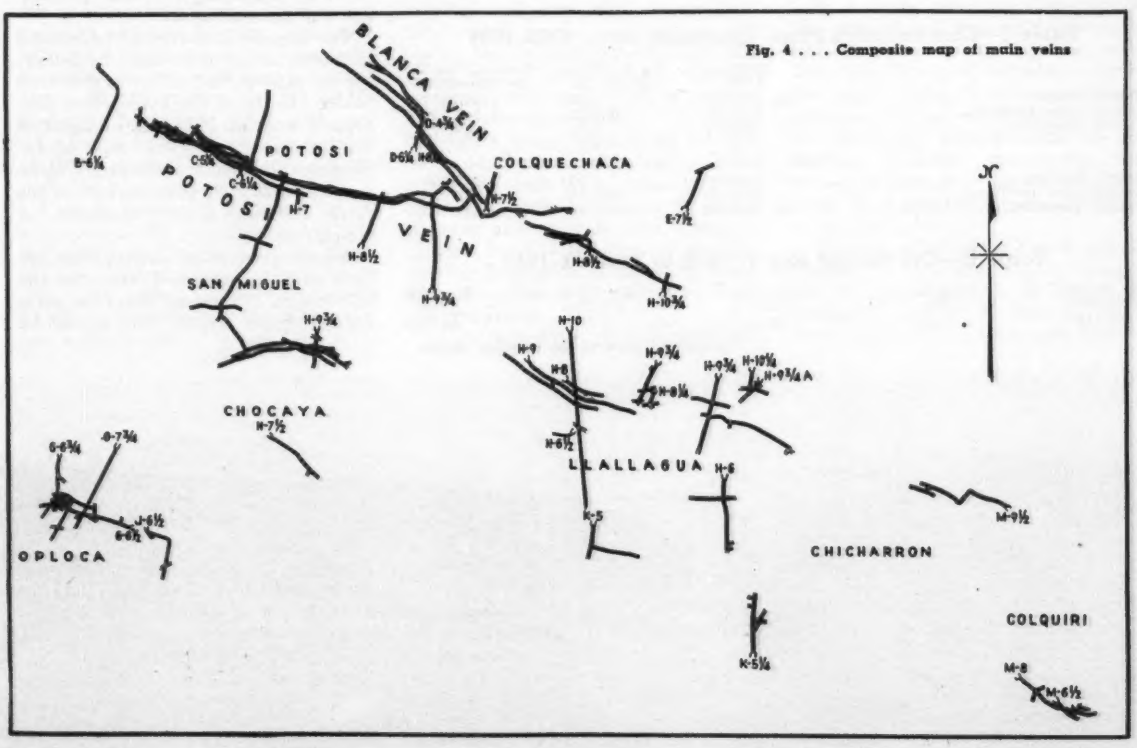

Fig. 4 . . . Composite map of main veins

75-ton ore bin. From the bin, ore passes over a 1½-in. grizzly and the oversize is fed by hand to a 7x10-in. Blake-type jaw crusher set at 1½ in. Here 10 per cent of the total feed is sorted out by hand as waste. The undersize and the crushed product are conveyed to a 1-in. screen and the oversize is fed to a No. 189 Allis-Chalmer fine crusher set at ¾ in., the products going to a 50-ton crushed-ore bin. From this bin the ore is fed by a Denver feeder to a 12x20-in. horizontal roll set at ¼ in. Crushed ore goes via bucket elevator to a 2x4-ft. Aero-Vibe screen fitted with ¼-in. square-mesh cloth, the oversize returning to the rolls. The undersize drops to a 3x6-ft. Aero-Vibe screen decked with ⅜-in. and ⅛-in. square cloth. Between the two screens there is an automatic sample cutter. The two coarse sizes go to two 16x24-in. Denver-type diaphragm jigs and the minus-⅛-in. to an hydraulic classifier and three No. 6 Wilfley sand tables. The jig tails are dewatered and fed to 8x10-in. horizontal rolls for re-crushing. This product passes another two-compartment diaphragm jig before going to the tails. The tailing is sampled automatically, and then dewatered and conveyed to a bin for loading into trucks.

A 40 percent tin concentrate containing 14 kg. per ton of silver is made. The plant treats 75 dry tons in 24 hours. Table III shows the ore treated for the year.

Recoveries made in this plant were 31.87 percent on the tin and 14.12 percent on the silver. Recent improvements have increased the tin recovery to 45 percent. Ratio of concentration is 44:1. The duty per man-shift for the year was 3.12 metric tons. Power consumption per ton milled for the year was 13.40 kilowatt-hours.

Flotation—The crushed and deslimed material from the Tres Palcas mill is transported in 5-ton trucks with trailers to the flotation plant. This is equipped with a 4x5-ft. ball mill with an Akins classifier in closed circuit. Denver Sub-A flotation machines are used. In closed circuit with the ball mill are two tables and a diaphragm jig. Sizing between the tables and the jig is done by a vibrating screen. This section makes a 40 percent tin concentrate containing silver. After flotation for recovery of silver sulphides and chlorides the pulp goes to six tables for further recovery of the tin and from there to buddles and the tailing pond. The plant treats 60 to 65 tons per 24 hours. Grinding is to 50 percent minus 200 mesh. Power consumption is 46.63 kw.-hr. per ton treated. Ratio of concentration is 31:1. Table IV gives operating data.

Recovery in this plant of the metals in salable products was: tin 27.07 percent and silver 73.13 percent.

Reagents used are as follows: Pine oil No. 5, 0.164 kg. per metric ton treated; No. 301, 0.131; CaO, 4.246; and Z-4, 0.068.

Table V gives the total production of concentrates from the vein section since the mine was discovered.

Ore Reserves—The ore reserves calculated as of June 30, 1940, are shown in Table VI. For these calculations a cut-off of 2.00 percent tin or 1.00 kg. per ton of silver was used.

These figures have been corrected by a 20 percent grade drop factor, found to be a safe one from comparison of mill head and stope assays over a period of two years. At the present rate of production the ore reserves will last two and one-half years.

Labor and Wages—Labor is plentiful, being drawn largely from Bolivia. It is fairly efficient but dulled somewhat mentally by the prevalent custom of chewing coca, a cocaine-containing leaf. Workmen are furnished two-room adobe houses. The company maintains a store at the mine. The average wage in the mine section for the year 1939–1940 was 4.68 pesos, or $1.17 U.S. At present slightly under 1,000 men are employed.

As required by Argentine law a hospital with 30 beds is maintained with a full-time doctor in attendance. All medical attention and drugs are furnished free to workmen and employees.

Taxes—No income taxes are levied on the corporation as such. However, there is a Provincial tax of 2 percent of the gross value of all concentrates.

Transportation — The concentrates are hauled 130 kg. from the mine to the railroad by 7-ton Sauer diesel trucks. The cost is 25 pesos per ton including road upkeep. From the railhead concentrates are shipped to Buenos Aires, the freight being 44.66 pesos per ton.

About half of the concentrates are smelted in the company-owned smelter in Buenos Aires and the rest exported, mostly to English smelters. All silver concentrates are exported.

Estimated Future Annual Production—Inasmuch as this mine produces practically all the tin concentrates in the Argentine, the following estimates of production for the next two years will be of interest: Fine tin in concentrates, 1,100 metric tons; fine silver in concentrates, 1,592,000 troy ounces.

Consumption requirements in the Argentine are estimated at 1,100 metric tons a year, or equal to the present estimated production from the Pirquitas mine. There is an import duty of 0.27 peso Argentine per kilogram of metallic tin.

Acknowledgments — Acknowledgment is gratefully made to J. C. Tonkin, general manager, and to the Board of Directors of the Sociedad Minera Pirquitas, Picchetti y Cia., for permission to publish this material. Acknowledgment is also due J. W. Ambrose for microscopic examination of minerals.

Laboratory Method for Zinc-Dust Precipitations of Cyanide Solutions

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THE following laboratory method of precipitating gold values from cyanide solutions was developed by the writer of this paper at the Santo Domingo mine of the Inca Mining and Development Co. of Tirapata, Peru, S. A.

The apparatus herein described is applicable primarily as a tool to determine the precipitation efficiency of zinc dust upon solutions of doubtful purity and for the obtaining of samples of zinc precipitate similar to those resulting from the Merrill-Crowe process in actual operation. Gold from solutions reused in cyclic testing may be precipitated between each test more accurately and under conditions more closely simulating those of actual plant operation than by merely agitating the solution in question in a bottle with an excess of zinc dust. The cyclic precipitation of solutions and the information obtained from the analysis of the zinc precipitate will often indicate changes, not anticipated from other test work, which must be made in the flowsheet.

Working on the premise that any pure cyanide solution containing sufficient cyanide and protective alkalinity may be precipitated with zinc dust, the first source of trouble when poor precipitation is experienced may generally be traced to impurities that have accumulated by the reuse of the solution. This condition is especially likely to develop on starting a new

plant wherein the concentrates or ores are of complex nature. On ores of this type laboratory cyclic testing becomes extremely important before a final flowsheet is adopted. The dissolution power of reused solutions often drops to a point where they must be discarded and precipitation may come to a standstill. I have observed such a condition at several properties, one in particular being at Mercur, Utah, in 1937, at the mill of the Mercur Gold Mines Co. In that instance the precipitation stopped and the gold which was already in the press seemed to go back into solution, only to be reprecipitated immediately as a colloid upon leaving the press. The barren solution assumed a deep purple hue and assayed very high.

Previous attempts to treat the Santo Domingo ores and particularly the sulphide concentrates were unsuccessful, partly from the inability to obtain solution of the gold but mainly from the failure to precipitate the solutions, which always became exceedingly foul after a short time. Part of the success of the present method of cyaniding these concentrates is a direct result of information obtained from precipitation and reuse of solutions used in the preliminary test work.

The apparatus as used is shown in Fig. 1. The layout of the apparatus, which is assembled of standard laboratory equipment, is shown in Fig. 2.

The distances from the deaërating bottle *D* to the zinc mixing bottle *Z*, and from *Z* to the precipitate bottle *P*, and from *P* to the sump *S*, are those used with the present apparatus and it is recommended that they be at least 18 in. and if convenient more, as the flow of solution after leaving the deaërating bottle *D* is by gravity. After the precipitate bag, which is inclosed in bottle *P*, becomes coated with zinc, the flow of solution is retarded unless there is sufficient drop between the units to supply a few ounces of pressure to the bag.

The separatory funnel *A* is of 2 liters' capacity and is held by a ring stand over the clarifying funnel *C*, which contains a small amount of glass wool and asbestos as a filter.

The deaërating bottle *D* is a 1,500-c.c. Woulffe flask with three necks and a tubulature on the side at the bottom. This flask is filled two-thirds full of freshly broken quartz, which serves to break up the flow of solution entering through valve 2.

The zinc emulsion cone C_1 is a small filter funnel which is stopped during operation with a conical rubber stopper into which a short piece of glass tubing has been inserted to serve as a handle. The zinc mixing bottle is a 200-c.c. wide-mouthed reagent bottle.

A good grade of flannel is used to make the precipitate collecting bag, which is 1 in. in diameter and 3 in. long.

The bag is attached to the tube entering the bottle *P* by tying with string over a rubber stopper and inserting the incoming tube through the stopper. The bottle *P* is a 200-c.c. wide-mouth reagent bottle. The solution after precipitation flows into the 2-liter sump bottle *S*.

A glass tube *B* connected to one of the necks of the Woulffe flask, and the other end submerged in a breaker of mercury serves as a gage to indicate the vacuum under which the bottle *D* is working.

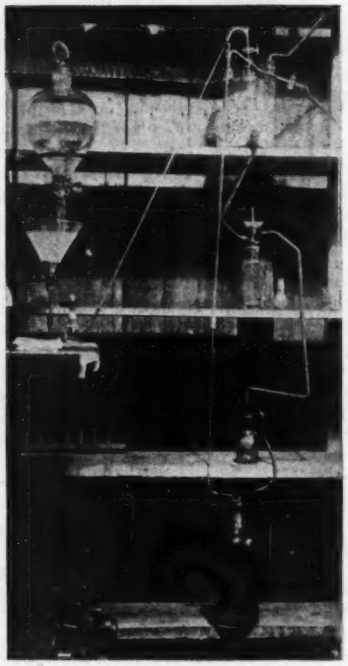


Fig. 1 . . . Laboratory precipitation unit used at Santo Domingo

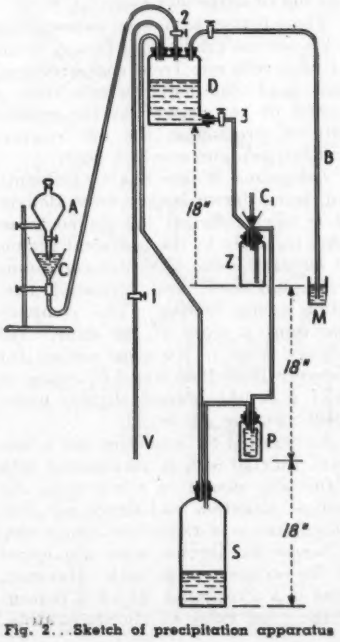


Fig. 2 . . . Sketch of precipitation apparatus

It is essential that the individual units be connected with glass tubing or rubber tubing that will withstand the atmospheric pressure without collapsing and that each connection and joint be absolutely airtight. The tube which is connected directly from the bottle *D* to the sump *S* allows the air which is displaced by solution entering the sump *S* to escape to *D* and be removed by the aspirator.

In operation, the vacuum line *V* is connected to a laboratory aspirator and the apparatus is put under vacuum with the valves 2 and 3 closed. When the mercury in the gage *B* has stopped rising (it should rise to at least 23 in. at elevations below 6,000 ft.), solution from separatory funnel *A*, which has been filled and stoppered previously, is allowed to enter the clarifying funnel *C*. When the solution rises above the discharge of the funnel *A* an air lock is formed and thereafter the level of solution in the clarifying funnel, being regulated by the air lock, will remain at nearly a constant level. The valve 2 is next partly opened and the solution begins to enter the deaërating bottle *D*. After *D* has become about two-thirds full of solution, valve 3 is opened and the solution begins to decend to the zinc mixing bottle *Z*. The level of solution in bottle *D* should always be kept above the discharge valve 3. It is also important that air never be allowed to enter the cone C_1 when adding zinc emulsion. If these precautions are not taken a vapor lock will frequently form in the line between the lower units and the solution will not pass downward.

The zinc cone C_1 is partly filled with an emulsion of zinc dust and a small amount of the solution being tested, and about ½-c.c. of this emulsion is allowed to enter the mixing bottle at intervals of about 5 min. If lead salts are necessary they may be added in measured quantities from a medicine dropper to the clarifying funnel *C*. It has been found that a small quantity of inert filter powder added through C_1 will improve the filtering qualities of the collecting bag.

About 30 min. are required to precipitate 2 liters of solution. The valve 2 is closed as soon as the last solution has been drawn from the cone *C* and before an appreciable amount of air has entered. The vacuum is maintained upon the apparatus until the solution has drained from *D* and *Z*.

To lower the vacuum on the apparatus the valve 1 is closed before the aspirator is stopped and air is allowed to enter by valve 2. The only solution retained by the system is that in bottle *P* surrounding the precipitated bag. This may be recovered by removing the bottle and allowing the bag to drain in a beaker. The solution recovered from bottle *P* will often have to be filtered before adding to the barren solution collected in bottle *S* for reuse.

Industrial Relations at Climax Molybdenum Plant

Well-defined policies on safety, health, housing, education, recreation, and security, administered with common sense, create favorable working conditions

James K. Richardson
Safety Director
Climax Molybdenum Co.
Climax, Colo.

General view of the Climax plant, taken from Chalk Mountain

NO HARD AND FAST set of rules or plans have been drawn up to cover our employer-employee relationships. We have recognized the fact that good relationship is good business. We early saw that certain physical disadvantages confronted all of our employees in that we were operating a property at 11,500 ft. altitude; and winter conditions were encountered for six months of each year. "Cabin fever" can confront a small community with the same appalling results as it can two lonely prospectors in a snow-locked cabin. Nerves are frayed, and there is always talk of "greener fields"; however, by applying common-sense principles to our employee grievances, as they have arisen, our major problems have been satisfactorily solved.

The best yardstick by which any one may measure the effectiveness of such a program is how rapidly men leave your employ. We find that as early as 1936, our labor turnover averaged 48 per cent per month. During 1940, this turnover was only 1.5 per cent per month. This compares very favorably with labor figures in old, established industries which have set up elaborate schemes for obtaining the same result.

Many things have contributed to this improved relationship. Each should be discussed, and even then, many of the details will be overlooked, for no person can say what the specific contribution any particular item has made.

Safety—Naturally, no man wants to work for a concern the practices of which are such that he may be killed or permanently injured. During the early days of mining, the chances were better than average that the miner would be killed at his work. Today, the modern mine operator has given his employees a better than average chance that he will not suffer a single disabling injury during his work-life.

Our company has set up a very definite and positive policy in regard to the prevention of accidents. A Safety Department, with a full-time engineer, supervises the provisions of this policy. That this policy is carried out and is effective is evidenced by the following figures on the number of accidents experienced per million man-hours worked.

Year	Accidents per 1,000,000 Man-Hours Worked
1931	166.38
1932	132.39
1933	157.67
1934	172.87
1935	44.85
1936	23.27
1937	21.71
1938	19.41
1939	17.42
1940	14.76

Any modern business executive can glance at the accompanying table and be at once aware that accident prevention was given serious consideration, first, in 1935. The methods used to achieve these results are not spectacular. Here, again, we have merely applied common-sense principles to our problem, the basic principles being education, discipline, and research.

Educational measures are pretty much standardized. We issue our men safety manuals for their guidance; they are taught our work methods; bulletin boards show the results of accidents here and elsewhere; safety inspectors are taken from employee ranks and educated in accident prevention measures before being eligible for promotion; first-aid training is provided; monthly safety meetings are held in each department; accident prevention contests are conducted throughout the plant; and other details too numerous to mention contribute to the educational principle.

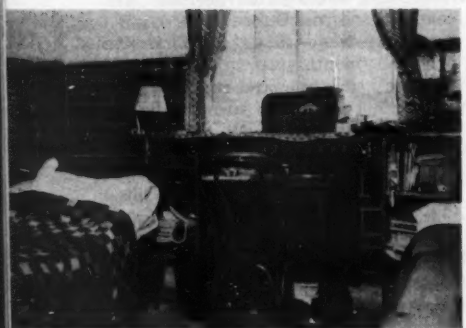
As a matter of discipline, we insist that each man, be he boss or mucker, follow our rules of safe procedure. Should a person be unwilling to follow our rules, we insist that he search for employment elsewhere. No man is discharged from our service, however, until such a discharge has been approved by the grievance court. This court consists of the personnel manager, the safety director, and the department head in whose department the man works. The person recommending the discharge or other disciplinary action appears with the employee and both are given full opportunity to tell each side of the story. A complete transcript of the testimony

is kept on each case. Upon completion all parties leave the room and the members decide on the penalty. A two-thirds majority is necessary to take any action against a workman. This court has reduced to a minimum personal feelings entering into discharges. Normally, cases are settled to the satisfaction of all parties concerned.

When an accident occurs, whether injury results or not, it is investigated immediately. If the investigation reveals mechanical failure or a failure on our part to provide suitable protection, we do not hesitate to shoulder our responsibility. Every installation of like nature is carefully checked and steps are taken to prevent a similar occurrence at another location. The mining method is being constantly studied and perhaps minor details changed to make for a better working condition. We have developed single-fingered grizzlies (large primary screens) so that the workman can never have an open raise at his back while working thereon. Bad ground is concreted to prevent possible roof falls. Over $500,000 has been spent the past year in developing and perfecting our mine ventilation system. Our metallurgists are constantly checking new equipment submitted for trial, and before approval it must stand up to exacting practical tests. All machinery purchased must be guarded by the manufacturer in accordance with accepted industrial safety standards.

Bowling alleys in the recreation club

Typical room in the boarding house



Typical company house

The cost of maintaining an effective safety program is considerable but not excessive. We have found the cost to be far less, in money, than that paid after the accidents have occurred. We believe that no single feature has contributed so much to the well-being of our employees as accident-prevention work.

Health—A man never stays long where suitable provisions are not made to care for his health and that of his family. This company has maintained a hospital at Climax since the start of operations. This hospital is staffed by two physicians, four nurses, and a cook. The building is a single-story structure and its architecture conforms to the general scheme of the other industrial and office buildings about the camp. Provision has been made that more space can be added, in the future, if needed. The floor plan provides a reception room, drug room, doctor's office, examining room, two wards, a kitchen, nurses' room, X-ray and developing room, operating room, and two private rooms. The total capacity is fourteen persons.

The "Hospital and Medical Service Plan" approved by the Industrial Commission provides that each employee living at Climax shall pay $1.50 per month, and those employees outside the camp $1.25 per month. Each man is, thereby entitled to such medical and surgical attention as is necessary, so long as the cost does not exceed $165 or six weeks for any one illness.

Consultation service is provided all employees and their families at the hospital office. House calls are made when deemed advisable by the chief surgeon.

The equipment used is of the latest type. We have available a late model General Electric 100 milli-ampere X-ray machine. We are equipped to handle any sort of surgery, and, if necessary, have available in Denver or Salida, excellent medical or consultation facilities.

Supplementing our regular medical and hospitalization program, we established a clinic during 1940. This was established so that we might thoroughly evaluate our industrial health hazard and perhaps "catch" non-occupational illnesses prior to their becoming serious. The policy relative to this clinic is best expressed by the notice which was posted notifying our employees of its establishment. It reads:

"In order to guard the health and safety of its employees, the Climax Molybdenum Company has established an Industrial Hygiene Department. Every employee of this Company may now obtain a physical examination on 'company time' at no cost to the employee. The Company in providing this service desires that its employees may be regularly advised of their physical condition so that suitable treatment may be taken to maintain the health, welfare, and safety of all employees.

"The Medical Department of this Company has been charged to keep the information obtained by these examinations in strict confidence, to be disclosed only in proceedings under the Workmen's Compensation Law of Colorado or in court action involving this Company, and in either of those events, the records and testimony of the Medical Department will then be available to both the Company and the employee.

"It is not the intention of this Company to discharge any employee as a result of any findings discovered during this physical examination, except in those cases where the Medical Department reports that the employee is suffering from a physical defect or disease that renders him a hazard to the safety and welfare of his fellow employees. If the physical examination indicates that a change of occupation would be beneficial to the employee's health, the Medical Department will assist the employee in presenting his case to the management with the view of securing from the Company the type of available employment best suited to the physical condition of the employee. The Medical Department will, also, recommend to the employee the proper treatment for the correction of those physical defects and diseases which may be found."

We are attempting to examine all of our employees at least once each year, and, in some cases, more often, depending on the nature of our findings.

All pre-employment examinations are made at the clinics, and we have purposely set our standards rather high, believing that our first duty is to our older employees and not the new man. The pre-employment examination is the same type as given all our men. We make a regular physical examination supplemented by electrocardiograms, chest roentgenograms; Wassermann tests; complete laboratory work; blood typing and any other tests which may complete the doctor's knowledge of the patient's physical condition.

It is felt that many interesting things may be shown by this group examination program. No comprehensive study of a group has ever been made at high altitudes, over a period of time, and there is little definite

knowledge of altitude's effect on the human system. This information is not available as yet, but after a number of years, it should be a definite contribution to medical science and the mining industry. There are many operations of similar character to ours at high elevations. In any event, the work will allow us to take better care of our employees, because we will often "spot" a condition long before the workman is aware of any sort of breakdown.

Housing and Schools—The present camp consists of 185 three-, four-, five-, and six-room homes. We have also converted the boarding-house annex and the old school house into apartments. All told, we have facilities at Climax for approximately 200 families. Most of the houses are for single families; however, some are duplex apartments.

The houses are of either frame or cinder-block construction. Some of the staff houses are provided with furnaces; however, the majority of the homes are not so equipped. All frame houses are thoroughly insulated with rock wool on sides and attic. All are provided with modern toilet, bath, and water facilities. All in all, the houses are as comfortable as can be found in any modern community.

Unlike the majority of mining communities, there is lacking that similarity of paint, design, and architecture. We have tried to have no two designs or colors together, thus giving the town the appearance of a normal prosperous community in which the residents have built their own homes.

The rents on the houses vary from $5 per room to $6 per room, depending on the facilities the home has available.

The single men are taken care of in a boarding house, which will accommodate 525 men. This is a brick-and-tile building, steam heated, and provided with the latest hardware, toilet, and washroom facilities.

The boarding house is generally the "sore spot" with any management. Seldom can the working men be satisfied by either food or facilities, which is in part due to management's lack of experience in conducting such enterprises as catering and housing and community projects. Our early experience was no different from that experienced elsewhere. We have, since analyzing the situation, leased the boarding house to the Anderson Boarding & Supply Co., which provides the men with board and room at the rate of $1.38 per day. We continue to supervise it, in that we can now pass on complaints to these experienced operators. Complaints, since the present system was inaugurated, have been at a minimum. Meals are served at tables (family style) and no man can truthfully say that he has ever gone away hungry. The rooms are cleaned daily, and clean linen is provided twice a week.

School facilities are housed in a large, two-story, fireproof building. All grades, from grammar school through high school, are in this building. The local school board has recommended and purchased the finest playground and educational equipment available. Graduates of the school are accredited to all Colorado universities.

Supplementing grammar school, we have been able to provide kindergarten activities for the younger children, which gives these children a background normally lacking anywhere except in the larger communities.

The camp has the benefit of splendid police and fire protection facilities. Employees secure fire insurance at a rate much lower than that normally enjoyed in a small community. These rates are primarily due to the two factors mentioned, and the well-planned building and spacing layout found throughout the camp.

Recreation—The community recreation program is centered in a modern, two-story, fireproof building. The upper floor consists of a gymnasium 120 ft. long by 85 ft. wide with a 22-ft. ceiling; a lounge or club room; a kitchen equipped with an electric range and complete service of dishes and silver; and a ladies' powder and rest room. The lower floor consists of an office; a game and card room; billiard and pool room; four regulation bowling alleys; a men's lounge; reading room and library; a writing room; rifle range and horse-shoe pitching courts; a shower and locker room; two guest rooms with bath; and an apartment for the recreation manager.

The personnel consists of a manager of the club and two assistants. They are responsible to a recreation club committee, which is composed of four members—the general superintendent, the safety director, the mine superintendent and the mill superintendent.

The club is maintained by dues from members. Each employee in camp pays $1.25 per month club membership dues. This entitles him to full use of the club. The only additional charges are the charges of 5¢-per "line" for bowling and 35¢ picture-show charge. All other activities are covered by the monthly dues.

Activities are varied so as to provide "something for everyone." Each night finds the gymnasium set aside for a different activity. Monday night is badminton. Tuesday and Friday nights are set aside for picture shows; using the latest R.C.A. sound system. Wednesday night is for men's indoor softball games, and later basket ball. Thursday night is for the women's softball league. Camp dances and school programs usually occupy our Saturday nights. Sunday school and church take up the space on Sundays.

Many clubs are sponsored by the recreation club. Among the most active are the ladies' bridge club, Boy Scouts, Campfire Girls, sewing club, rifle club, ski club, bowling league, camera club, and an Intermountain Branch of the Colorado Section of the American Institute of Mining and Metallurgical Engineers.

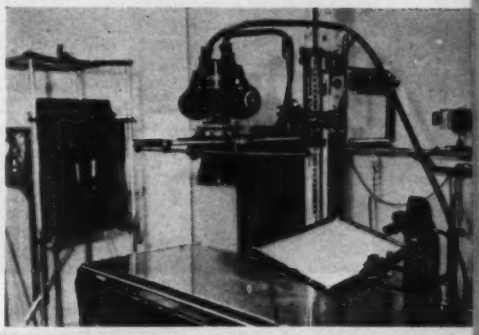
Some one of these many and varied activities provides an outlet for any normal desire for recreation. The major portion of the residents of the camp participate in one or more of the clubs and enterprises.

Security—The matter of "job security" is something which materially concerns every man. Approximately 78 percent of our employees are married and have children. All of these do not live in Climax; some residing in Leadville and other nearby towns.

On all lay-offs which have been necessary we have tried to adhere rigidly to making these reductions on a seniority basis. We have, however, given all married employees a three-month preference over single men. During a period in which we are employing men, we write, wire, and tele-

Typical room in the hospital

Modern X-ray equipment in the hospital



Modern fire-fighting equipment

phone those men originally laid off and offer them the new jobs prior to accepting men from the "rustling line." Any rehired through these measures are reinstated with their original hiring date, which adds to their seniority period. We find that at present 75 percent of our employees have been continuously in our service for 3½ years or more.

Over 60 percent of our men were originally unskilled workmen who have been trained in our work methods here. They were originally farmers, ranchers, and laborers who had little or no knowledge of mining practice; and 65 percent are under 35 years of age.

Each employee is eligible for group insurance after being in our employ three months. This insurance is carried through the Metropolitan Life Insurance Co. Half the cost of this insurance is paid by our company and the other half by the employee. This amounts to $1.30 per month and entitles the man to a $1,000 policy carrying "health and accident" benefits of $10 per week for thirteen weeks. Minor staff members are given on the same basis a $3,000 policy with no "health and accident" benefits at $1.80 per month.

All of our workmen, naturally, are covered by the Workmen's Compensation Act, which provides specific payments for occupational accidents.

We have made a conscientious effort to rehabilitate any workman who has been the victim of an unfortunate accident in which his working ability has been lessened. We have made jobs, in many cases, for such individuals, always trying to place them on a wage scale comparable to that which they were drawing before their injury.

Vacations—During 1939, the management decided to extend the vacation privilege to all employees who were not on the regular vacation list. It was decided that all employees who worked a minimum of 230 days between June 1 and May 31 would be entitled to six days' vacation at the regular weighted average hourly rate received during the last two weeks prior to May 31. The first vacation was well and favorably received by all employees on July 3, 1940. Operations were resumed again on July 11, 1940. The vacation pay was paid in advance, to all eligible on the pay day preceding the vacation period.

Change Rooms—Perhaps no single item, unless it be the boarding house, has caused more industrial strife in mining areas than poor change rooms. At our mine we have attempted to give our men the very latest change-room facilities. We have a number of rooms. The man can take off his dirty clothes in one room and walk, naked, to the shower room for his bath; from the shower room he can take a ride on the conveyor through the solarium; and thence to his locker in a separate room.

The dirty clothes are hung near the ceiling, and by use of hot air blowers and adequate ventilation, the work clothes are thoroughly dry at the beginning of his next shift.

The solarium gives the miner artificial sunlight which he fails to get during his working shift. The value of this equipment has been controversial, but some individuals feel that their resistance to colds and other pulmonary disorders has been built up through its conscientious use.

Summary

We stated earlier that we had no fixed plan relative to industrial relationships. It is felt, however, that having provided our men with safe working conditions; good medical facilities; good homes and schools; and satisfactory recreational, working, and other miscellaneous facilities, our problem has been successfully handled. Our feeling is that we have a group of men in our employ who are assets to any community and assets to us, and that they appreciate our efforts and have only the most cooperative feeling toward us. This has been brought about, we believe, by applying common-sense principles to grievances as they arose. We know that it is a definite asset to have men in managerial capacities who have come "through the ranks" and can see potential grievances before they arise.

Climax boarding house. Mt. Arkansas in the background

Table arrangement at the boarding house

The dry room at the mine

Max Schott public school. Ten Mile Basin in the background

Analyzing Results of Mining Enterprises

The author offers a procedure involving three fundamental factors: grade of ore processed, volume of such ore, and operating economy

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MANAGEMENT is primarily the job of *control through measurement.* Few fields afford more fascinating or more rewarding opportunities for the measurement and coordination of operating performance and financial results than does the mining industry.

The analysis of mining operations necessarily follows two principles or methods. First, the facts may be *expanded* to bring out the last detail of each aspect of results obtained. Second, the facts may be *condensed* to reveal the underlying causes responsible for the trend of the business *as a whole.* Both of these methods are obviously necessary if the management is to be provided with the most meaningful information.

By *expansion,* costs are broken down by departments and by component cost elements on both an absolute and on a per-ton basis, thus uncovering leaks and weaknesses in various particular phases of any operation. Great stress has justifiably been laid on the importance of such detailed breakdowns. But *condensation* is of equal importance, for there is such a thing as being swamped by a sea of figures—of caring for the individual trees while neglecting the forest. Certainly the ideal is obtained if there can be made available for management not only the necessary detail but also an interpretation of operating results in terms of a very few underlying, fundamental factors.

The factors to which we refer and which basically determine the profit or loss of a mining enterprise for any given period are: (1) the grade of ore processed, (2) the volume of such ore, and (3) operating economy. A moment's thought will reveal that these three common denominators really underlie the operating results of *all* active mining operations, regardless of their *type* or *size* or *location.* They are fundamental.

Now it is obvious that if the operating results for a certain period can be reduced to the three factors enumerated, the *trend* of operations can be precisely shown by the favorable or unfavorable variations in such factors as between one period and the next. Such variations are obtainable by simple comparison.

The purpose of this paper, then, is to show concretely how the net difference in the operating profit or loss of any mining company, in successive accounting periods, can be *measured precisely in terms of three fundamental variations,* that is, by:

1. Variations in the *Grade of Ore* processed, as measured by the average *gross value per ton,*
2. Variations in the *Volume of Ore,* as measured by the *number of tons mined and treated,* and
3. Variations in *Operating Economy,* as measured by the *total cost per ton* (which of course may be broken down by departments and component cost elements whenever desired).

In order to grasp the full value and implications of this method of analysis, let us first observe a concrete example based on an actual mining operation:

The preliminary figures upon which our example is based are exhibited in Table I. The concern used as an example is designated the X.Y.Z. Mining Co. As for the periods of time covered by the statement, they could be months, quarters, years, or any other accounting periods for which an analysis was desired.

It will first be noted that the X.Y.Z. Co. had an operating profit of $20,488.15 in the accounting period recently ended, against an operating profit of $20,497.88 for the prior period, the net difference therefore being a decline of only $9.73. But it would be erroneous and superficial to conclude that the fundamental operating factors had therefore remained the same. On the contrary, all three of the key profit-determining variations changed significantly. In fact, the exact effect of each factor in contributing to the decline of $9.73 in the operating profit, as determined by our analysis, may be summed up concretely as follows:

1. Operating economy (as measured by total costs per ton) improved, for total costs were reduced 10.75485¢ per ton, which had the effect of *increasing* operating profit by	$2,011.80
2. The volume of ore mined and treated gained 1,416 tons, which had the effect of *increasing* operating profit by	$1,678.72
Gain in operating profit from favorable changes	$3,690.52
3. The grade of ore (as measured by the average gross value per ton of ore processed) declined, for the values decreased 19.87107¢ per ton, which had the effect of *decreasing* operating profit by	$3,700.25
Net decrease in operating profit	$9.73

Table I—X. Y. Z. Mining Co. Condensed Comparative Summary of Operation in Two Successive Accounting Periods

	Present Period	Prior Period	+Increase —Decrease
Gross value of metals	$81,673.06	$78,910.75	+$2,762.31
Operating costs:			
Marketing costs	$630.02	$704.48	—$74.46
Milling costs	21,186.42	19,765.49	+1,420.93
Hauling ore, mine to mill	8,753.96	7,948.62	+805.34
Lease royalties on ore mined	3,902.60	3,585.20	+317.40
Mining costs	19,007.64	19,268.16	—260.52
Yard, camp and transportation	3,923.34	3,330.13	+593.21
Administrative expenses	3,780.93	3,810.79	—29.86
Total operating costs	$61,184.91	$58,412.87	+$2,772.04
Operating profit	$20,488.15	$20,497.88	—$9.73
Tonnage mined and treated	18,706	17,290	+1,416
Derived Per-Ton Data			
Average value of ore per ton	$4.3661424	$4.5639531	—$0.1978107
Total cost of ore per ton	$3.2708708	$3.3784193	—$0.1075485
Operating profit per ton	$1.0952716	$1.1855338	—$0.0902622

Thus it is plain that if the grade of ore had remained constant in both periods the company would have increased its operating profit by $3,690.52 in the period recently ended because of *greater output* and *greater efficiency*. Here, then, are the vital and controlling facts brought into condensed focus for the use of the management.

A somewhat more amplified form for summarizing these results is presented below. This form sets forth for comparison more of the underlying information. First it breaks down the change in operating profit into increases or decreases in (A) Total Revenue and (B) Total Costs. Then the total revenue is in turn broken down into (a) the volume-of-ore factor and (b) the grade-of-ore factor; and, similarly, the total costs are reduced to (a) the volume-of-ore factor and (b) the operating-efficiency factor. Moreover, the pertinent tonnage, millhead, and per-ton cost figures for *each period*, as well as the net changes as between the two periods, are given. Here is the analysis in the form described:

A. Revenue increased $2,762.31, because:	
(a) The volume of ore handled was greater by 1,416 tons (18,706 as against 17,290), accounting for a *revenue increase* of	$6,462.56
(b) Offsetting this, the grade of ore was lower by 19.78107¢ per ton ($4.3661424, against $4.5639531), accounting for a *revenue decrease* of	3,700.25
Total increase in revenue ($81,673.06, against $78,910.75)	$2,762.31
B. Operating expense increased $2,772.04, because:	
(a) More ore was handled (18,706 tons, against 17,290), accounting for an *increase in costs* of	$4,783.84
(b) Offsetting this, efficiency improved through a reduction in expenses by 10.75485¢ per ton ($3.2708708, against $3.3784193), accounting for a *decrease in costs* of	2,011.80
Total increase in operating expense ($61,184.91, against $58,412.87)	$2,772.04
C. Net profit decrease ($20,488.15, against $20,497.88)	$9.73

The core of the operating trend has now been laid before the management. Operating efficiency and the quantity and quality of ore handled have all been definitely correlated with the financial results the X.Y.Z. Co. actually attained. The point has been reached where the analysis is ready to be translated into executive action. We now turn, therefore, to a brief discussion of the practical applications of the analysis just presented.

(For the benefit of those engineers and accountants who may be interested, the mathematical theory and the step-by-step computations made in preparing the above analysis are presented in an Appendix. All of the figures in the above summary as well as in the appendix are traceable to Table I, already introduced, which provides the "raw material" for the entire analysis.)

The general applicability of the three-factor analysis just introduced rests upon the fact that, despite great diversity in size, methods operating conditions, and other characteristics, the essential process in *all mines* is that of converting rock into refined metals through the employment of manpower and machine power, the whole process being financially reflected by a continuous flow of dollars going into the operation and a continuous flow of dollars coming out of it. Such is the very nature of the business of mining. Accordingly, the central problem of mine management is to arrange and apply the manpower and machine power in such a way as to get the most effective interaction between (1) the grade of ore, (2) the quantity of ore, and (3) the amount expended per ton of rock processed. The competent mine manager or mining engineer will be quick to see how the dollars-and-cents measurement of these fundamental variations each month and each quarter will help him enormously in translating operating performance and operating ideas into successful financial results. It will of course be no novelty to him to apply a new principle or a new formula to the specific situation confronting him. Nevertheless, the value of analyzing operating results in terms of the three fundamental factors can perhaps best be demonstrated by showing its use in connection with some typical operating problems.

A problem common to the operation of all mines is the differentiation of the rock that is truly ore and should therefore be processed and the rock that is submarginal and should accordingly be either left behind or sorted out before it reaches the crusher. Suppose, for example, that a particular mine is extracting gold-silver-lead ore which is readily distinguishable from the waste. The practical question then is: Can a sorting operation and a selective method of mining be devised which will raise the millheads enough to more than pay for (a) the extra cost of the additional sorting process, plus (b) the lower tonnage probably to be entailed by the more selective mining of the ore? Or, viewing the question in the light of the analysis at our disposal: Would the new sorting operation cause the grade-of-ore factor to increase operating profit enough to more than offset the adverse effect of less tonnage and higher costs per ton? It is axiomatic that at all times only that rock should be processed which will produce the best long-run financial results. But the answer is difficult because the values carried in the submarginal ore are an unknown quantity which must be taken into consideration. In this typical situation, it is obviously important for the management to be able to follow as closely as possible the exact profit effect of any experiments in ore sorting and selective mining. Clearly the best way for it to arrive at the point of maximum profitableness is to analyze each month's operating results in terms of the three fundamental factors.

The thing to remember in all cases, of course, is that the grade of ore and the values extracted mean nothing except in relation to total costs. *Margins* determine *results*. In the case of the X.Y.Z. Co. the total cost per ton, or break-even point, had been about $3.38. The grade of ore had been gradually declining with depth. The physical occurrence of the ore was such that there was no visible line of demarcation between the rock that was 50c. per ton either above the margin or below it. Selectivity was clearly out of the question. The only possible solution was to break the ore in larger quantities and tram it on a larger scale with bigger equipment, even though some dilution was bound to occur. This was done and the analysis of results obtained in terms of the three basic operating factors showed the wisdom of the step taken, for, as we have already seen, the margin of profit was maintained through better *volume* and better *efficiency* despite the decline of 20c. per ton in the average value of the ore handled.

To give another illustration of its usefulness, the three-factor analysis can often be employed effectively by mines which are characterized by recurring up-and-down cycles in their grade of ore. I have seen a number of instances where resident managers were temporarily applauded by Eastern stockholders when profits improved because ore values at the moment were rising, even though operating economy was all the while becoming gradually more lax. This relaxation did not come to light until the analysis revealed it. In such enterprises it is of course vital that economy and efficiency be just as strictly maintained during periods of rising values. Otherwise the average long-run profit expectancy, embracing periods of both good values and bad, will not be achieved. It is the paradox of the inexperienced mining concern to be constantly suffering from either too little money, foreing wasteful expediency, or too much money, causing laxity. These common faults can be remedied only by the frequent and unflinching application of impartial, impersonal yardsticks in the form of strict accounting control.

Many other illustrations of the specific uses of the three-factor analysis might be given. But in all instances the management's procedure upon receiving the figures will follow the same

general lines. First, upon ascertaining the exact influence of each of the three variations on comparative operating results, the thoughtful management will always ask: "Which of the elements are fixed and uncontrollable, and which are manageable and subject to improvement?" In few if any cases will it be found that either the grade of ore or the volume of ore or operating economy are either wholly controllable or are entirely beyond control. Broadly considered, the inclination at first blush is to think of the many ways in which the *scale* and *efficiency* of mining operations can be stepped up through engineering skill and genius coupled with modern equipment. But it should not be overlooked that the *grade-of-ore* factor is likewise subject to considerable human control because it requires unusual knowledge and ability to *find the ore and keep it.* That explains why the industry places such a high premium on the successful geologist and why a mine superintendent "with a nose for ore" is the answer to a manager's prayer.

In conclusion, the breaking down of operations into the three key factors, as stressed in this study, serves above all else to bring the operating picture as a whole into focus. With this analysis as a nucleus, management can study with detached clarity and perspective the detailed analysis of particular aspects of the operation with the object in view *of correlating the details with total results.* The net variation in the grade of ore, for example, can be further analyzed by metal values, and the value variations on each metal can in turn be accounted for by the pounds or ounces produced and by the different prices at which it was sold.

For an even more specific illustration, the reduction of 10.75c. per ton in the over-all costs of the X.Y.Z. Co. is easily amplified further by Table II, which, among other items, includes a reduction in per-ton milling costs of 1.06c. In logical sequence, the latter is in turn analyzed further by Table III, and, carrying the analysis still further, the composition of the single item of Materials and Supplies can be resolved into six sub-items—namely Treatment Materials, Grinding Balls, Ball Mill Liners, Gasoline and Lubricants, Repair and Tools parts, and Other Supplies. And these items could be even further subdivided. The breakdown process can thus be carried to almost infinite lengths, yet it all springs from a *central nucleus.*

The paramount value of our condensed analysis therefore lies in the fact that it relates every phase of operating detail back to the three fundamental determinants of profit. It lends dynamic realism to the basic precept of management that "if we could only know *where we are* and *whither we are tending* we could better know *what to do* and *how to do it.*" In a word, it crystallizes for the use of management the essential factors which govern the operating results of all mining properties.

Appendix

The mathematical basis for the analysis given in the foregoing sections is inherently simple. At bottom, the computations rest on four elementary facts, viz.

1. Profit is determined by two elements: income and costs.

2. Both mining income and mining costs are fundamentally *products of multiplication* since the physical unit of measurement for the ore mined and treated is the ton. The total income is therefore the net result of multiplying the number of tons processed by the *value per ton.* Likewise, the total cost is the net result of multiplying the number of tons processed by the over-all *cost per ton.* Mining operations are "multiple" in their nature.

3. The net variations in the factors can easily be obtained by simple subtraction.

4. By means of substitution and elimination, the exact force of each factor—its positive or negative effect upon operating profit in dollars and cents—can be determined. This is done by neutralizing the effect of "foreign" elements at each stage of the computation, so that the net effect of each individual factor, operating by itself, can be ascertained. As economists or physicists say, *"Other things being equal,* the effect of a given force will be such and such." Here too the idea and purpose are to make "other things equal."

Now, employing exclusively the derived per-ton data at the bottom of Table I, we shall proceed to show how the actual dollar-and-cents effect of the variations in grade of ore, operating economy, and tonnage are respectively determined.

Grade-of-Ore Factor

In the period recently ended the millheads of the X.Y.Z. Co. were 19.78107¢ lower than in the prior period, computed as follows:

(a) $81,673.06 (revenue) divided by 18,706 (tons) equals $4.3661424 (mill heads, *recent* period).

(b) $78,910.75 (revenue) divided by 17,290 (tons) equals $4.5639531 (mill heads, *prior* period)

Subtracting (a) from (b):

(c) $4.5639531 less $4.3661424 equals $0.1978107 (decrease in grade of ore).

The tonnage in the two periods was of course different. This influence is neutralized, however, if we multiply the decline in millheads between the one period and the other by the *recent period's* tonnage, for this eliminates the tonnage differential. Doing this, we find that if other factors had remained constant the lower grade of ore would have *reduced the operating profit* $3,700.25, computed as follows:

18,706 tons x $0.1978107 (per "c" above) = $3,700.25 (answer).

At this point it might be explained parenthetically that the decimal is carried out to seven places in all the per-ton figures because they have to be multiplied by large figures representing tonnage, and only by such extension of the decimal can an accurate answer in dollars and cents be obtained.

Operating-Economy Factor

The exact effect on operating profit attributable to the improved efficiency attained by the X.Y.Z. Co. in the period recently ended is computed in the same manner as was the grade-of-ore factor. The reasoning is the same in all respects. The computation follows (top first column) on page 48.

Table II—X. Y. Z. Mining Co. Condensed Comparative Analysis of Total Per Ton Costs
Two Successive Accounting Periods

	Present Period	Prior Period	+Increase —Decrease
Marketing costs	$0.0337	$0.0407	—$0.0070
Milling costs	1.1326	1.1432	—0.0106
Hauling ore, mine to mill	0.4680	0.4597	+0.0083
Lease royalties on ore mined	0.2086	0.2074	+0.0012
Mining costs	1.0161	1.1144	—0.0983
Yard, camp and transportation	0.2098	0.1926	+0.0172
Administrative expenses	0.2021	0.2204	—0.0183
	$3.2709	$3.3784	—$0.1075

Table III—X. Y. Z. Mining Co. Condensed Comparative Analysis of Per-Ton Milling Costs
Two Successive Accounting Periods

	Present Period	Prior Period	+Increase —Decrease
Labor and labor costs	$0.3660	$0.3258	+$0.0402
Materials and supplies	.3432	.3643	—.0211
Power	.2998	.3154	—.0156
Service from other departments (laboratory, machine shop, warehouse, etc.)	.0970	.1096	—.0126
Property insurance and property taxes	.0266	.0281	—.0015
	$1.1326	$1.1432	—$0.0106

(a) $61,184.91 (total cost) divided by 18,706 (tons) equals $3.2708708 (cost per ton *recent* period)

(b) $58,412.87 (total cost) divided by 17,290 (tons) equals $3.3784193 (cost per ton prior period)

Subtracting (a) from (b)

(c) $3.3784193 less $3.2708708 equals $0.1075485 (decrease in per-ton costs)

Therefore, applying this change to the recent period's tonnage, the net contribution of better operating economy *toward greater profit* was $2,011.80, to wit:

(d) 18,706 tons × $0.1075485 (per "c" above) equals $2,011.80 (answer)

Volume-of-Ore Factor

If a mining company is deriving an operating profit of so much on each ton of ore mined and treated, it is manifest that the more tons it processes the greater the operating profit will be. This is true because the per-ton profit will be made *more times* with *more tonnage*. Thus *volume* is a separate factor in itself, independent of the grade of ore and operating economy. Now, to neutralize the latter two factors, and to segregate and measure the volume-of-ore factor, the *tonnage increase* in the *recent period* must be multiplied by the per-ton operating profit of the *prior period*. Following is this determination.

(a) 18,706 less 17,290 equals 1,416 (increase in tonnage)

(b) 1,416 (per "a" above) × $1.1855338 (per-ton operating profit of prior period) equals $1,678.72 (answer)

The effect of variations in the *volume-of-ore* factor on operating profit can also be segregated into (1) its influence on *revenue* and (2) its influence on *expenses*. This is self-evident because the per-ton operating profit, as used in the foregoing computation, naturally consisted of the per-ton revenue less the total per-ton cost. In reality, then, the greater tonnage acted to increase operating profit by exerting two forces, one on revenue and the other on expenses, as follows:

More tonnage (1,416) increased revenue by $6,462.56. Computation: 1,416 × $4.5639531 (value of ore per ton of prior period).

Effecting this, the processing of this additional tonnage increased costs by $4,783.84. Computation: 1,416 times $3.3784193 (per-ton operating cost of prior period).

Operating profit increase from greater ore volume (as before) $1,678.72

The volume-of-ore factor thus has a twofold effect. It is always one of the two blades of the scissors affecting both the *revenue* variation and the *expense* variation.

Proof and Final Remarks

Proof of the computations is quickly afforded by a recapitulation of the answers obtained for each of the three factors measured which together, it will be recalled, caused the decline of $9.73 in the X.Y.Z. Co. operating profit. Here is the recapitulation:

1. The poorer grade of ore served to decrease the profit	$3,700.25
2. The greater economy of operation served to increase the profit by	2,011.80
3. The larger volume of ore served to increase the profit by	1,678.72
Net decrease in operating profit	$9.73

Because all active mining operations, large and small, metallic and non-metallic, can advantageously analyze their operating results in terms of the three fundamental forces herein determined, pains were taken in the foregoing exposition to detail each step taken as well as the mode of reasoning involved in determining the profit variation attributable to each factor. It was felt that the potential importance to the industry of this three-factor analysis of operating results more than justified a complete "X-ray" explanation of the procedure.

To conclude, it would be most unfortunate if the impression were gained that the analysis required the services of a mathematician, or required excessive time and labor to perform. On the contrary, once the essential facts are known and the underlying principles are grasped, the whole analysis can be worked out very quickly and within the confines of a small sheet of paper. To demonstrate this simplicity, and to sum up the entire foregoing exposition we present below the complete computation just as it would be done in any specific case.

From these figures the formal analysis statements (such as appeared earlier in the article) may be easily drawn up.

It will be evident to anyone giving this analysis real study that it penetrates to the heart of what is actually taking place in any practical mining operation.

Profit Factor	This Period	Prior Period	—Increase +Decrease	Times Multiplying Factor	Profit —Increase or +Decrease
Tonnage ...	18,706	17,290	—1,416	$4.5639531	—$6,462.56
Millheads ..	$4.3661424	$4.5639531	+$0.1978107	18,706	+3,700.25
A. Net revenue variation (increase)					—$2,762.31
Tonnage ...	18,706	17,290	—1,416	$3.3784193	—$4,783.84
Per-Ton Cost	$3.2708708	$3.3784193	+$0.1075485	18,706	—2,011.80
B. Net expense variation (increase)					+$2,772.04
Net decrease in operating profit					+$9.73

A Safe Powder Car

EFFECTIVELY INSULATED against fire and sparks and capable of holding a maximum of twenty cases of explosives, the powder car shown in the accompanying line drawings has proven a valuable addition to the underground rolling stock at the Banner and Central mines of Lava Cap Gold Mining Corporation, situated near Nevada City, Calif., according to John W. Chandler, the general superintendent.

As will be seen, the unit essentially consists of an all-steel body, measuring 30x30x60 in. and lined inside with old conveyor belting and 1½-in. wood flooring, and a four-wheel truck employing conventional 10-in. mine car wheels. The Carten sides and top of the body are made from ⅛-in. steel plate, and bracing consists of 4-in. channels, and ¼x1½-in. strap iron. Both 4-in. and 3-in. channels are used in the construction of the truck.

Loading and removal of explosives is facilitated and speeded up by the movable sides of the car body, which are held in place and locked by the latch arrangement shown in Fig. 2.

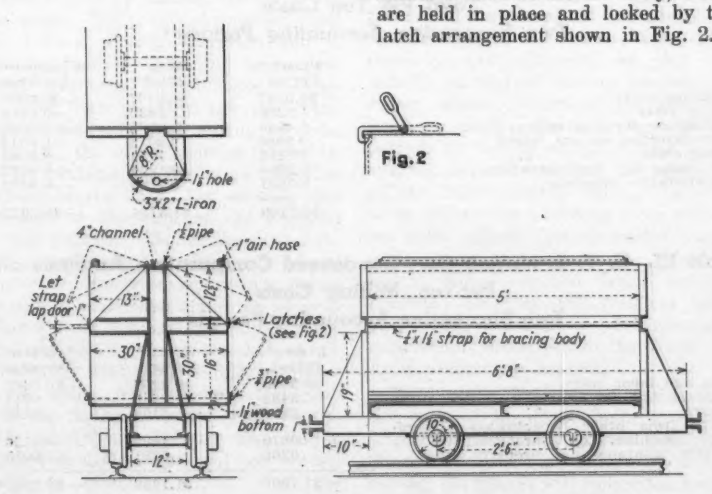

Fig. 2

New Power Plant for Rosiclare Fluorspar Operations

Electric pumps replace flooded steam pumps. Additional and more reliable power required underground and in flotation plant

J. M. Edwards
Electrical Editor

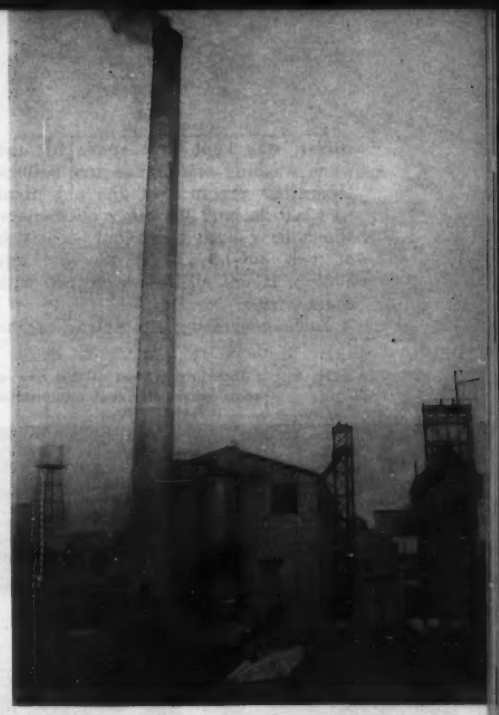

Fig. 1 . . . Additional flood margin afforded by the new plant is 9 ft. The cooling tower shows in the background between water tank and stack and to the right of the stack is the round ash hopper. Down between the steel structures of the skip coal hoist and mine headframe is the truck ramp for fuel delivery

ELECTRICITY having amply demonstrated its advantages in economy of transmission and utilization, the Rosiclare Lead & Fluorspar Mining Co., headed by J. M. Blayney, of St. Louis, and superintended by A. H. Cronk, turned to construction of a new electric generating plant as the first step in a series of improvements which are powered by electric motors. The new plant, completed late in 1939 and which furnished the electricity for dewatering the Rosiclare (Ill.) shaft which had been flooded since 1924, now supplies the electric power for its regular pumping and is scheduled to supply the fans, underground hoists, and motor-generator sets for regular operation of the mine. A new froth-flotation plant added at the mill constitutes another new load.

Other reasons besides the additional pumping load entered into the decision to construct a new plant. There was the urge to obtain a better efficiency from the fuel and an opportunity to reduce plant maintenance cost and to get a plant on ground of higher elevation than the old and thus be less vulnerable to Ohio River floods. The public utility has never seen fit to make high line power available to this district of southern Illinois. Regardless of that condition, however, the use of a steam hoist, which is a Nordberg double-drum 18x42-in. twin-corliss handling 6,600 lb. of ore per skip, practically dictated the continuance of a boiler plant.

Flood waters of 1937 reached a depth of 8½ ft. in the engine room of the old plant, resulting in a shutdown of the electric generators from Jan. 22 to March 4. Although the new plant has been built adjacent to and incorporating parts of the old, it is 9 ft. higher as regards flooding. Ground of higher elevation immediately back of the old plant accommodated the construction at a higher level. Farther back still higher ground provides the site for the cooling tower.

Sixty-cycle engine-driven 2,300-v. alternators of the old plant, one a 450-kw. driven by a Nordberg uniflow engine and the other a 300-kw. driven by a Chuse non-releasing corliss, were left in place to serve as spares. Positions of the two air compressors, both 1,250-c.f.m. Ingersoll-Rand, were not changed, and one of the old boilers, a 500-hp. Stirling type with chain grate

Fig. 2 . . . New plant for the largest fluorspar producer in the world. Since this photograph was made a flotation plant was built at the right

stoker, was kept as a spare for use when washing one of the new boilers. Operating pressure of the old plant was 140 lb., and the other old boilers, which have been taken out, consisted of two 300-hp. B. & W. and one 300-hp. Heine, all three equipped with chain grates.

Turbo-generating equipment of the new plant, housed in a new steel-and-brick engine room, consists of two 3,600-r.p.m., 2,300-v. reconditioned units, one a Westinghouse 1,000 kw. and the other an Allis-Chalmers 1,250 kw.

Steam at 180 lb. and 100 deg. F. superheat is generated by two new 600-hp. straight tube B. & W. boilers with Laclede chain-grate stokers. These boilers are fitted with Hays automatic combustion controls supplied by the Economy Equipment Co., of St. Louis, and with Copes feed water regulators and Vulcan soot blowers. Ash is transported to an elevated truck-loading hopper by a steam-jet unit made by the United Conveyor Corporation.

Coal storage is in a 300-ton track hopper and a 50-ton bunker. An automatic skip elevates from hopper to bunker, and distribution from there to the stoker hoppers is by a Jeffrey weighing larry mounted similarly to a bridge crane. Normally the coal is delivered by motor trucks to an inclined trestle over an extension of the track hopper. This fuel is 1¼x0-in. grade, which in the Rosiclare plant evaporates 8½ lb. of water per pound of coal and is purchased from the West Kentucky Coal Co. The latter ships by barge from Sturgis, Ky., and maintains its own derrick boat at the Rosiclare company's wharf and also assists in barge loading the concentrated gravel-grade fluorspar.

Fig. 3 . . . The turbine floor of this new engine room is 9 ft. higher than the old engine room where the engine-alternators, now spares, were flooded in 1937

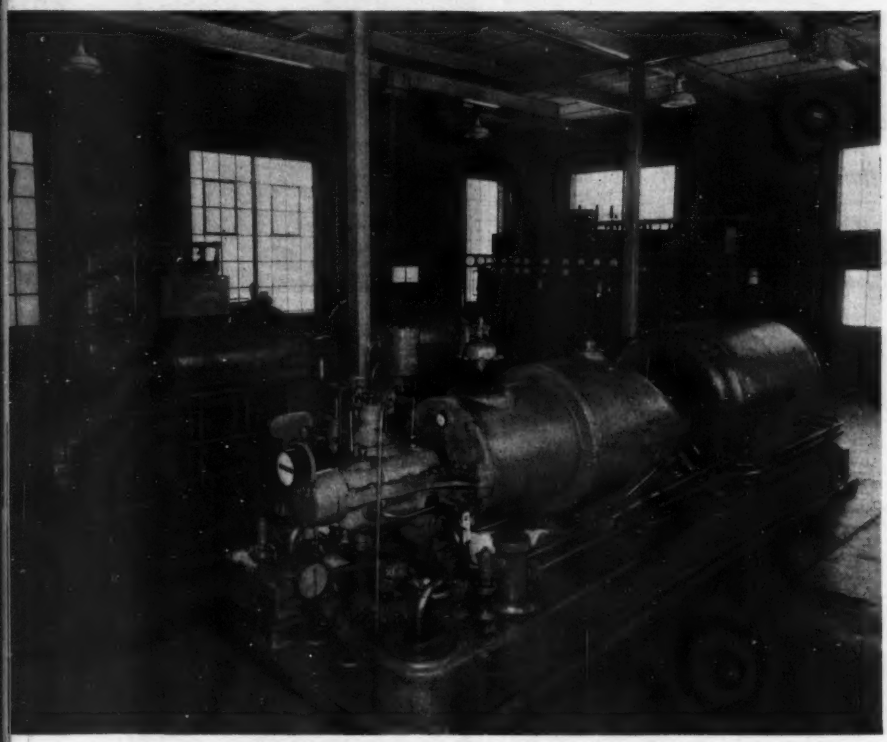

Fig. 4 . . . The two new 600-hp. boilers (left) are set at higher elevation than the old 500-hp. boiler (extreme right) which serves as a spare

The plant stack, designed and erected by the Rust Engineering Co., is concrete, 185 ft. high, inside diameter 13 ft. at the bottom and 8 ft. at the top. A firebrick lining extends up 100 ft. The boiler house is a steel structure with galvanized-steel siding and asbestos roofing.

A cooling tower erected by Lillie-Hoffman Cooling Towers Incorporated, of St. Louis, operates with forced draft produced by four fans driven by General Electric two-speed 1513.7-hp. motors. At present this cooling tower finds little use, because water pumped from the mine is forced through the condensers and is ample to produce the necessary vacuum. Only when the mine water gets muddy is the cooling tower put into use. An effort is to be made, however, to cut off by grouting or other means the underground stream which is entering the Rosiclare shaft from the footwall on the 612-ft. level.

Feed water make-up for the boilers is taken from the city supply, which is filtered Ohio River water. For boiler use it is softened by a Permutit zeolite unit.

This electric generating plant of the Rosiclare Lead & Fluorspar Mining Co. furnishes power to two other producers of fluorspar. The Hillside Fluorspar Co. uses it for the local mining operations and to drive its mill. Also, the Mahoning Mining Co. takes a 24-hour continuous demand at its new mill and flotation plant. That three-shift operation at Mahoning and the same hours at the Rosiclare flotation plant, plus the furnishing of light and power to the town, give the plant a 35 per cent monthly load factor.

The Baumes Engineering Co., of St. Louis, was the consultant on this power-plant project.

Once Again the Standard Sieve Scale

The author hits upon something interesting after devising his own logarithmic cross-section paper

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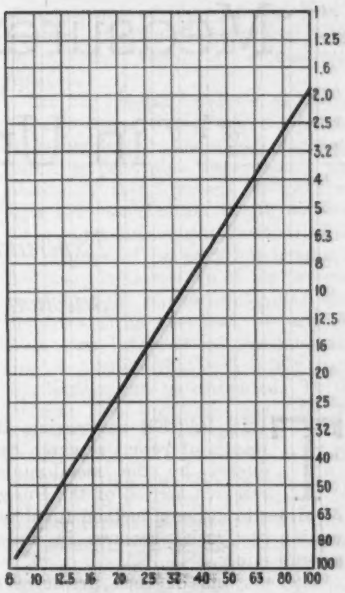
ONE CAN MAKE A SLIDE rule of a sort with the edges of two pieces of uniformly ruled paper with the lines marked with values consecutively double the previous one: 1, 2, 4, 8, 16, etc. In making some plots of screen analyses, and in the absence of specially ruled logarithmic paper, the same scheme was adopted at first and gradually evolved into one which I consider better than the special paper.

Ordinary quadrille ruled paper is used as customarily employed for rectangular coordinates. The numbers in the list, 1, 2, 4, etc., are given three spaces each, the result being that there are ten spaces between 1 and 10, or between 10 and 100. The intermediate numbers are 1.25, 1.6, and multiples of these. What has actually happened is that we have numbers whose logarithms start with 0 or 1 and vary by 0.1000. In plotting, slight errors will not show up, and an error of 2 per cent in a square about ¼ in. on the side is about the width of a pencil mark. So the numbers used are simple ones and easy to remember: 1, 1.25, 1.6, 2.0, 2.5, 3.2, 4, 5, 6.3, 8, 10, and those in which the decimal point of these is shifted. The 6.3 is the most accurate of the lot, a glance at the table of logs in any hand book showing that there is no error greater than 2 per cent.

In specially ruled log. paper, there are wide spaces and narrow spaces, and in some of these with varying values location of points is uncertain. In the type described, however, the ratio between lines is constant, each square is capable of the same amount of error in plotting, and with a little experience plotting may be more accurate than on the specially ruled. The availability of this log. paper led to the following, in the course of a discussion respecting standard sieve scales:

Standard sieve scales are discussed periodically. Writing on something published some time ago to the effect that it was a pity that the United States Bureau of Standards kept to its own Screen Sieve Scale when the Tyler had been generally adopted, I put down that a study would show both having numbers which were in no direct relation to the openings, and that the scale of the Institute of Mining and Metallurgy of Great Britain was better in that one could use either mesh or opening but that the heavy wires employed might make considerable trouble for the manufacturer of equipment.

Thus all were criticized, to which the reply was: "If you are so clever, why don't you do something better?" And this is what came out of it. To begin with, there are too many sizes for ordinary screening. Some screen analyses had been plotted on the logarithmic paper that has been described, and the intention of suggesting a new system had been disclaimed by the writer.



Illustrating the author's logarithmic cross-section paper

But trying the log. paper mentioned, and its numbers being used, the multiplier between inches and millimeters is hit almost squarely (slightly off center), and we end up with a system which uses about five numbers for inches, inch mesh, millimeters, millimeter mesh, and the ratio between opening and wire spacing (the latter depending on the manufacturer concerned):

A slight error is introduced, for 1 in. is equal to 25.4 mm., whereas the table is made up on the assumption that 1 in. is equal to 25 mm.

Such a system of screen scales would be made up properly on the metric basis, with any deviations in accuracy leaning toward the inches. It would be accurate enough for any present work on the English system of measures.

As the numbers used are supposed to vary by 0.2000 in their logarithms, starting from zero, intermediate sizes would have their logarithms varying from these by 0.1000. But for most work these sizes would be amply sufficient.

Except in the coarser screens, the ratio of hole opening to centers of wires is about 1/1.6 in present practice—near enough to suggest that this ratio be maintained somewhat in the manufacture of such a new system. However, the manufacturer will find many of these suggested sizes close to present standards or tabulated in lists of screens which he can make or easily have compiled, the ratio of hole to centers being rather immaterial to the user.

Opening Inches										
1.0	0.63	0.4	0.25	0.16	0.10	0.063	0.04	0.025	0.016	0.01
Inch Theoretical Mesh										
1.0	1.6	2.5	4.0	6.3	10	16	25	40	63	100
Meter Theoretical Mesh										
40	83	100	160	250	400	630	1000	1600	2500	4000
Opening Millimeters										
25	16	10	6.3	4	2.5	1.6	1	0.63	0.4	0.25

Measurement of Rock Pressures in Underground Mines

Experimental work based on velocity of sound and detection of subaudible noises yields encouraging results

Leonard Obert [2]

THIS PAPER summarizes the results of recent research conducted by the metal-mining research section of the Bureau of Mines to devise a method for determining the rock pressures in underground mines.

The subjects of rock pressures in mines, subsidence of strata over and adjacent to mine excavations, mechanics of pressure development, and causes of rock bursts have received increasing study and attention in recent years. Although numerous valuable articles concerning these studies have appeared in the technical literature, prior to this investigation no method for determining or even approximating the actual rock pressures had been published.

In mining, it is necessary to rely on experience for decisions as to safe lengths of unsupported spans in stopes and as to sizes of stope and floor pillars. In the United States alone, millions of tons of good ore remain in pillars in open-stope mines. Some of this ore now is in process of recovery, and probably most of the remainder will be mined some day. In recovering this ore a method for determining the actual rock pressure would be of immense value, from the standpoint of both safety and economy.

In view of the need for some quantitative method of measuring these pressures, C. F. Jackson, chief engineer of the Mining Division, and McHenry Mosier, supervising engineer of the metal-mining research section of the Bureau of Mines, first undertook some investigations in 1936 which they hoped might shed some light on the problem. They thought that in view of the important rôle that sonic methods had played in the field of geophysics, there might be some sonic method of attacking the rock-pressure problem. Two possible methods were proposed. First, there might be some sonic property of the material such as the velocity of sound or the frequency of vibration, which, if it varied sufficiently with the pressure, might be used as a measure of the pressure; or, second, there might be some microscopic readjustment in the rock when pressure was applied which would give rise to noises that could not be heard with the unaided ear but when amplified could be detected and used to serve as an indication of the pressure. Such noises are hereafter referred to as subaudible. The latter method has a disadvantage that it does not lead to quantitative measurements and accordingly the former method was first considered.

Of the quantities which can be measured sonicly, most attention has been given to the velocity of sound. The velocity of sound is related to the pressure through the simple equation

$$V = \sqrt{\frac{E}{d}} \qquad \text{Equation I}$$

where V is the velocity of sound; E is Young's modulus of elasticity; and d is the density. E is equal to the stress divided by the strain or simply the ratio of the force applied to body to the corresponding deformation. If the stress is plotted against the strain for such materials as metals or glass, the resulting curve is a straight line within the elastic limits of the material. As E is the slope of this curve, it is a constant and hence independent of the pressure. Thus, the sonic method is not applicable to such materials.

Preliminary investigations by Bureau of Mines engineers, as well as by other investigators, had shown, however, that the modulus of elasticity of rock varies with the pressure, which suggested a sonic means of measuring rock pressures. Briefly, the method requires, first, a laboratory determination of the variation of the Young's modulus with pressure in samples of rocks taken from mine pillars to establish a velocity-pressure relationship for the type of rock, and, next, measurements of Young's modulus in the same mine pillars from which the laboratory samples were taken. The pressure on the pillars can be determined by correlating the modulus of elasticity in the pillar with the E-pressure relationship established in the laboratory. Obviously the success of the method depends on the extent to which E varies with pressure in rock.

The first step in carrying out this problem was to develop a simple, yet accurate, laboratory method for measuring the variation of E with pressure for small specimens of rock. This was accomplished by mounting the specimen as shown in Fig. 1, in which A is the rock sample, B are the jaws of a mechanical press, and C are hardened steel end plates. The purpose of the end plates is to transmit the pressure to the specimen without restricting its freedom to vibrate. The specimen, thus mounted, was vibrated electrically at its fundamental frequency. The velocity of sound in the specimen was determined from the frequency by the equation

$$V = \frac{2\sqrt{12\,L^2 f_s}}{\pi t} \qquad \text{Equation II}$$

where f_s is the frequency, L is the length of the specimen, and t is the thickness. E was calculated from the velocity by the use of equation I. This measurement was repeated for pressures from zero to the crushing strength of the specimen.

Some representative results from these studies are shown in Fig. 2, in which the change in Young's modulus is plotted against the pressure. It was concluded from this data that with the exception of Indiana limestone this change was sufficient to warrant extending the method to field measurement.

The next step was to develop a method for measuring the modulus of elasticity in actual mine pillars. Because of its size it is not practical to produce sustained vibrations in a pillar, and instead the following method was developed. When a sound wave is produced at the base of the pillar by a light hammer blow or other means, it travels up the pillar with a velocity equal to the velocity of sound. If two sensitive vibration microphones, usually referred to as geophones, are placed

[1] Published by permission of the Director, Bureau of Mines.

[2] Physicist, metal-mining research section, mining division, Department of the Interior, Bureau of Mines, College Park, Md.

along the axis of the pillar at a known distance apart, they will intercept the wave as it arrives and produces a corresponding electrical impulse. Now, if the time between these electrical impulses is measured and divided by the distance between the geophones, the result will be the velocity of the sound wave from which E can be computed by equation I. While this method is perfectly straightforward, there is one difficulty—namely, the velocity of sound in rock is often as high as 20,000 ft. per second, and inasmuch as the geophones cannot be placed more than 20 to 40 ft. apart, the actual time for the sound wave to traverse this distance is of the order of 0.001 to 0.002 of a second. As this time interval must be measured accurately —that is, at least within 1 percent— actually, in order to obtain this accuracy it is necessary to measure in increments of 0.00001. It was necessary to design and construct suitable equipment because there was no apparatus on the market that would make such measurements.

The time measurements were made with a high-speed moving-film oscillograph, and so as to have a sufficient resolving time, the film had to move at the rate of 120 ft. per second—that is, approximately 80 miles per hour.

The method was first tried out in the lead mines in southeastern Missouri. The mining method employed in this district was that of open stopes with irregularly placed pillars for roof support. This district was chosen for the first test because these pillars are well suited for this type of measurement; and, moreover, they contain a large quantity of ore.

Fig. 3 shows the plan of the stope selected for the first tests. This stope is approximately 350 ft. below the surface, and is in a fairly uniform dolomitic and glauconitic limestone which carries several rich seams of galena. Observations were made in the southern end of the stope. The height of this stope averages about 40 ft. at the center of the arch, and the arch span is approximately 100 ft. at the narrowest point and over 200 ft. at the widest point.

A plan was worked out to check the proposed method of measurement. It was decided to select one pillar (No. 4, Fig. 3) and reduce its horizontal area by slabbing so that the pressure per unit of area would be increased. Velocity measurements were to be made not only in the test pillar but in the pillars surrounding it (Nos. 1, 3, and 7, Fig. 3). This would show then not only the increase in pressure in the test pillar but would also indicate if there were any increase in the surrounding pillars during this time. This method was carried out, and when the measurements on the pillars were compared with the laboratory results, it was found that not only was there no increase in pressure in either the test pillar or any of the surrounding pillars, but that none of these pillars was under a pressure sufficient to be measureable. Subsequently, the test pillar was cut free from the back and the pressure measurement repeated on surrounding pillars, and still no increase was indicated.

The question has been raised as to how the pressures on the arch due to the load above are distributed in the rock surrounding large underground openings similar to that in which these tests were made. A possible answer is that the arch carries the major part of the load as compressional forces, the pillars serving mainly to stabilize the arch. This supposition is at least partly substantiated by the fact that when the test pillar was removed, no difficulty was experienced with the arch. If this is the case, it will markedly alter the economics of pillar removal in open-stope mining. In at least two mining districts the construction of concrete replacement pillars and subsequent removal of the ore pillars has been considered economically possible. However, if the ore pillars could be safely reduced to one-half or one-fourth of their present size, it becomes doubtful if concrete pillar replacement would be economically justified.

The St. Joseph Lead Co. is one of the companies conducting a program of research on concrete replacement pillars to determine the economic possibility of this process. Its program calls for construction of 16 concrete pillars and subsequent removal of 12 ore pillars. Of primary importance in this study is knowledge of the pressure exerted on the replacement pillar when the load from the back is applied. With this information, the minimum size of a pillar that will safely stand this burden can be estimated. To determine this optimum size, the St. Joseph Lead Co. is employing the following method: First, samples of the concrete from the replacement pillars are sent to a testing laboratory, and the modulus of elasticity and the crushing strength are determined. Second, the contraction per unit length of the pillar (that is, the strain) is measured when the load from the back was applied. The stress in the pillar could then be calculated from the value of Young's modulus as determined in the laboratory and the safety factor obtained by comparing the stress with the crushing strength. The essentials of the pillar construction are shown in Fig. 4. A is a stainless-steel rod anchored near the top of the pillar, and B is a stainless-steel stud mounted near the base of the pillar. The contraction in the pillar is determined by periodically measuring the gap between A and B with a micrometer. A number of screw jacks are placed between the back and the top of the pillar. These serve a dual purpose; namely, to insure good contact with the roof and to take up or relieve the pressure as desired. The principal difficulty experienced in this method is to obtain a representative value of Young's modulus for the pillar. A large number of samples must be averaged and corrections made for the

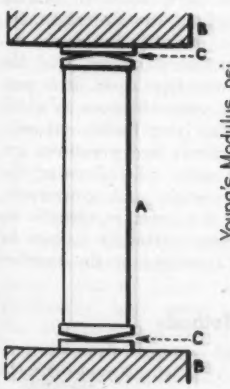


Fig. 1 . . . Supported mounting in press

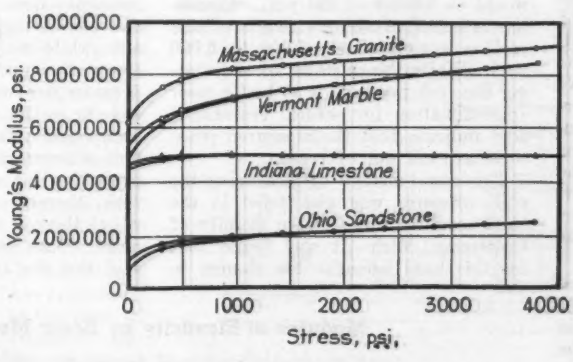


Fig. 2 . . . Relation between Young's modulus and stress for four building stones. The upper part of each curve is for the initial loading, the lower part for all subsequent loadings

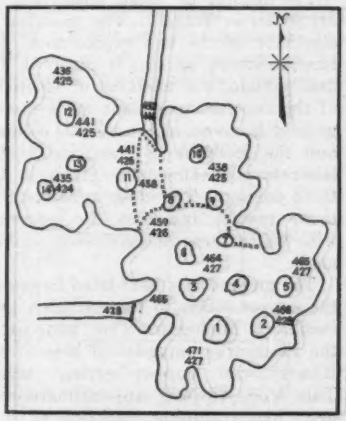


Fig. 3 . . . Sketch of a stope in a lead mine in Southeastern Missouri

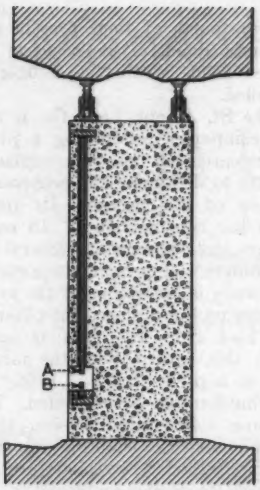


Fig. 4 . . . Longitudinal cross-section of concrete replacement pillar

steel reinforcement. Owing to variations in the test specimens and uncertainties in the corrections for the steel reinforcement, the value of the modulus so obtained is subject to considerable error.

As the apparatus used in the rock-pillar tests gives the velocity, and the modulus of elasticity can be obtained from the velocity by Equation I, this method also offers a simple way of determining the elastic modulus of the concrete pillars *in situ*.

Accordingly, two unloaded test pillars were selected and velocity measurements made in exactly the same way in which they were determined in the rock pillars. At the same time, two beams were made in the mine from concrete used in construction of the replacement pillars. These were cured underground for 28 days and then shipped to the laboratory for testing. Later, two beams were made in the laboratory of the same materials and mixed in the same proportions as were those made in the mine. These were cured for 28 days in moist air at 60 deg. F. and then tested.

The results of these measurements are given in Table I. The modulus of elasticity of the two replacement pillars measured *in situ* is given in the first column, the modulus of elasticity of the two test specimens made underground is given in the second column, and the modulus of elasticity of the laboratory specimens is given in the third column. The close agreement of these results indicates the accuracy with which these measurements can be made.

The method was next tried in one of the copper mines in the northern peninsula of Michigan. This mine is in the Kearsarge amygdaloid lode of the Keweenawan copper-bearing series. This lode, dipping approximately 35 deg., has a stoping thickness of 6 to 10 ft. at the present operating depth. The ore occurs in reddish amygdaloid varying widely in hardness. The mining method employed is a retreating system of open stoping, with regularly spaced rib pillars. Present operating depth of the mine is 3,000 to 5,000 ft. from the surface on the vertical, and the investigations reported herein were carried out at a vertical depth of 3,000 to 4,000 ft. At this depth there is considerable evidence of pressure, such as movement of the hanging wall, crushing of pillars, and rock bursts.

The method of increasing the pressure on the pillar through a reduction in its area by slabbing, as was done in the lead mines, could not be employed here, due to the small size of the pillars. Instead, the first pressure measurements were made in the face of the stope at a place designated for a rib pillar. As the mining advanced and the pillar was formed, subsequent measurements were made in the same location until the stope was worked out. This system of testing was used so that the increase in pressure on the pillar could be measured as the unsupported arch span was increased. When the field measurements were compared with the data from the laboratory specimens, it was found that the pressure increased only about 10 percent during the entire period. The point of most interest was that the pressure on the stope face before the pillar was started approximately equaled the crushing strength of the rock. While this may be surprising, it is not inconsistent with other observations. For one thing, these pillars show visual signs of failure such as cracking and spalling even before they are cut free from the face. Another verifying fact is that rock bursts often occur in the face of a stope, as was the case during the forming of this pillar. This is a definite indication that the pressure, at least on some local area, has reached the crushing strength of the rock. Furthermore, if the pressure due to the weight of the overburden at this depth is calculated, assuming it to give rise to a uniform force acting vertically downward, the pressure would be 4,000 to 5,000 p.s.i., whereas the measured crushing strength of this rock is approximately 5,000 to 6,000 p.s.i. While this method of calculating the rock pressure is at best a poor approximation for several reasons, it does indicate that the measured pressures are not out of reason.

This sonic method of measuring the rock pressure was also tried in the hard hematite mines in the vicinity of Ishpeming, Mich. It was found that for this hard hematite the change in Young's modulus with pressure was very small, and consequently this method of measurement was not applicable.

To summarize the results of these pressure measurements, it has been demonstrated that it is possible to measure rock pressures by this method, provided the modulus of elasticity of the rock changes appreciably with the pressure. It is recommended that any company desiring to make such measurements should first determine the elastic behavior of the rock before proceeding with the field measurements.

It was mentioned at the beginning of this paper that a second possible method of detecting rock pressures existed—namely, the use of subaudible noises. The geophones that are used for the pressure measurement are in essence sensitive vibration microphones, and if earphones are attached to the amplifiers, a method of "listening" to rock is provided. During the progress of the pressure measurements previously described, it was always customary to make these noise observations.

In the lead mines in southeastern Missouri it was found that there was no rock noise of any nature, and, correspondingly, there was no pressure in this area that approached anywhere near the failure point of the rock. This was also true of the lead and zinc mines in northeast Oklahoma, with one exception. This exception was a pillar which showed some visible evidence of failure and correspondingly there was a small amount of noise—that is, one or two disturbances every five minutes. This pillar is over 20 years old and from all appearances will still stand for some time. The point of interest is that even in a process acting so slowly there is some noise accompanying the rock failure.

The outstanding example of subaudible noise is in the deep copper mines in Michigan previously described. In the lower levels of this mine there is a continuous background of noise, sounding much like static on a radio during an electrical storm. These noise measurements have been made in mining districts throughout the United States, and while no quantitative scale between the amount of noise and the pressure has been developed, it is possible to make a generalization to which no exception has been found—namely, that wherever there are pressures approaching the point of failure of the rock, there is noise, and, conversely, where there is no pressure there is no noise. With less certainty it can be said that the intensity or the number

Modulus of Elasticity by Sonic Methods

	E (Dynes per cm²)		
Test	Pillars Measured *in Situ*	Samples Made Underground	Samples Made In Laboratory
1	2.06×10^{11}	2.20×10^{11}	2.05×10^{11}
2	2.00×10^{11}	1.90×10^{11}	2.18×10^{11}
Average	2.03×10^{11}	2.05×10^{11}	2.11×10^{11}

of disturbances increase with the pressure.

Another possible use of a sonic method is in detecting "loose" rock in the back of mine openings. The customary method of spotting "loose" rock in metal mines is to test the back with a piece of drill steel and if it gives a good ring it is considered solid, whereas if it sounds "drummy" it is loose. This method becomes increasingly difficult as the size of the "loose" rock increases, because there is less difference in the ring.

By placing a geophone in the solid rock and listening to the amplified sound it has been found that it is possible to make a better discrimination between the character of the sound than with the unaided ear. This discrimination can be still further improved by using electrical filters in the amplifier which removes the low frequency components of the sound.

During the course of some seismic investigations in the copper mines in northern Michigan it was noted that the ground, which was normally "quiet," became "noisy" (by noisy is meant amplified subaudible noise) and that the noise continued to increase for about 15 minutes until it terminated with a rock burst which occurred not over 50 ft. from the point of observation. It is evident that, if there is always an increase in the noise immediately before a rock burst, it could be used to predict rock bursts. This incident started a program of research on the use of subaudible noises for predicting rock bursts.

No record is kept of the number of rock bursts that occur in these mines; in fact, this would be difficult, because some of them occur in inactive parts of the mine and others when there is no one in the proximity to note their occurrence. There are frequent rock bursts, of varying degrees, every day soon after blasting. It was noted that the rock bursts occur in cycles, the duration of which and the interval between which are quite irregular. The rock-burst periods may be one day or one month, and often the comparatively quiet intervals are of even longer duration. It was noted further that the rock bursts usually occur in the hard-rock section of the mine. This is possibly explained by the fact that the softer rock yields under pressure, allowing the arch to distribute the pressure over wider areas, whereas the hard rock supports the load until its crushing strength is reached, when it breaks with characteristic violence.

The method employed in this investigation was to place two geophones, preferably near some active part of the workings that are frequently subject to rock bursts. The geophones were planted in drill holes in the solid rock about 100 ft. apart, and were connected to individual amplifiers, the output of each being connected to a film recorder and to ear phones. The moving film recorder made an individual record of the impulses from each geophone, and it is from this record that the number and types of disturbances were studied.

There are several types of disturbances in the rock that could be identified from their corresponding impulses on the film: First may be listed those caused by cracking of the back near the geophones, and second, similar disturbances that occur at more distant points. The third group includes small disturbances near the geophones and the fourth comprises those disturbances due to rock bursts.

It became evident soon after this research was begun that one recorder alone could not serve as a basis for a statistical study of this nature, because, even though, on an average, there may be several rock bursts a day in the mine, the probability of its being in the right location at the right time is rather remote. As the data were not as complete as could be desired, it is planned at a later date to continue the investigation using several recorders.

However, the results were adequate for the following conclusions:

First, before and during a period in which rock bursts are occurring the number of disturbances, particularly the major disturbances (first type), is very large; conversely, during periods in which there are no rock bursts the number of disturbances is very low. The number of disturbances in a noisy period may be as much as 10 or 20 times the number in a quiet period.

Second, this method of investigation is localized; that is, disturbances coming from more than 1,500 ft. away are small and difficult to identify, and each recorder is, therefore, effective only within a circle of this radius.

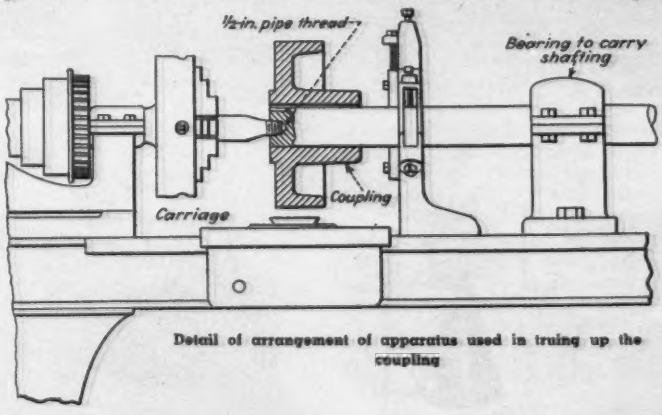
Third, with less certainty it can be said that there is an increase in the number of disturbances immediately before (within 15 minutes of) a rock burst, although this increase is less pronounced during rock-burst periods.

A method such as that described in the foregoing would not be satisfactory unless it could be used while the miners were in the stopes. It was found, however, that there is enough difference between the rock disturbances and those caused by the miners to permit using a selective type of recorder. The Bureau of Mines is designing a number of such recorders and is planning to resume the research in the mines in the near future.

Due to the scope of this paper and the limitation of space, it would be difficult to make the proper individual acknowledgments. The Bureau of Mines is, however, deeply indebted to all of the mining companies that cooperated in this research.

Truing Up a Large Coupling

AFTER placing a flange coupling on a shaft, whether it be shrunk, pressed, or keyed on, it is necessary to true up the face if satisfactory results are wanted later, writes Charles Labbe, Johnnie, Nev. At a western mill where the lathe was considered much too small, the following device was used: A piece of 1¼-in. round stock (the size of the jaws) was fastened in the chuck, turned down, and threaded to ½-in. pipe thread. A hole was bored at the center end of the shafting and tapped to ½-in. pipe. The lathe's steadyrest was placed at a short distance from the coupling, with bearings to suit and carry the weight: one near the end of the lathe bed and one rigged out to carry the shafting. The coupling end of the shaft was screwed tight to the piece in the chuck and recentered as to the shafting, and the coupling was trued by two very light cuts. Another coupling on the mill drive was trued in place by means of an emery block, held in a wooden clamp, checked by a straightedge, the mill power rotating the shaft. The sketch shows the general arrangement. The carriage, which is not shown, is between the chuck and the coupling.



Detail of arrangement of apparatus used in truing up the coupling

KAOLIN, Incorporated, Producer of Carolina Clay and Mica

Its deposit, in the Spruce Pine district, is unique in respect to tonnage and characteristics, and vies in interest with the adjacent modern treatment plant and its unusual equipment

A. H. Hubbell
Associate Editor

Above, In this basin between river and ridge is Kaolin, Inc.'s, extraordinary deposit of primary clay. Behind the treatment plant to the left can be seen the white surface of the open pit. This picture was taken recently by T.V.A. Below, Looking down the mine conveyor into the pit. The tunnel is exposed for part of its length. At the far end is the building housing the scraper hoist. Note depth of overburden on far bank

FIVE MILES northeast of Spruce Pine, in western North Carolina, are the open-pit mine and treatment plant of Kaolin, Incorporated, organized in June, 1936, to work a deposit of primary kaolin, or china clay, that in respect to quality and tonnage is outstanding in the United States. The company is an operating company and has a long-term lease on the mineral rights on the holdings of the Carolina Kaolin Corporation, amounting to 4500 acres. This property lies in a basin between the North Toe River and a crescent-shaped ridge known as Humpback Mountain. The region is rugged, wooded and well-watered, normal rainfall amounting to 57 in. per year. Elevation at the mine is 2750 ft. above the sea. The deposit of kaolin, as delimited by prospecting, appears to cover approximately a square mile without a break, being the largest known. Estimates place its content of refined clay at several million tons. Here a modern treatment plant was installed by Kaolin, Inc., in 1937. An additional plant for recovering the mica contained in the crude material or matrix was completed last summer.

Kaolin, Inc. is an Indiana corporation and has the following officers: Howard S. Marmon, who lives at Pineola, N. Car., 15 miles away, is president; and D. I. Glossbrenner, of Indianapolis, secretary-treasurer. The late W. C. Marmon was vice-president at the time of his death in August, 1940. D. E. Jones is assistant to the president, and James A. Barr, Jr., is superintendent and development engineer. R. G. Janatka is sales manager. Mr. Marmon has kindly consented to the publication of this article. It was Mr. Barr who accompanied me over the surface and through the plant on my recent visit and I am indebted in the main to him for the information here related.

The efforts that culminated so recently in the entry into production of refined clay by Kaolin, Inc., had their beginnings some fifteen years ago when a group that combined experience in ceramic work, geology and

mining undertook to investigate the possibilities of the southern Appalachians as a source of primary kaolin, with the idea of supplying a superior raw material to American pottery makers accustomed to looking to foreign sources to meet such needs. The quest had for its objective the discovery of deposits of primary kaolin, or kaolin that had remained in place as the rocks yielding it had decomposed, in contrast to possibly less pure secondary or sedimentary deposits. A prolonged and wide-spread search ensued at considerable expense, despite the fact that work was even then being done to improve the clays from secondary deposits in the South. Examinations were made over an extensive area, in part with the co-operation of the State Surveys, and eventually the deposit in the Spruce Pine area was brought to attention and its merit proved. H. J. Bryson, former State Geologist of North Carolina, is credited by the company with having given important aid, particularly by urging consideration of the virgin mountain areas in his State.

Out of this endeavor grew the Carolina Kaolin Corporation, owner in fee of the lands acquired, and then the operating company. Today the group in control is much the same as it was originally. Much money has been spent, particularly in working out a treatment process that would provide a product satisfactory to the ceramic and paper trades. In this an important contribution was made by the ceramic laboratory of Tennessee Valley Authority at Norris, Tenn., collaborating with a committee of the American Ceramic Society in studying the Tennessee Valley clays.

Geologically, the region consists of northeast-southwest trending, folded gneisses and schists, intruded by granites and pegmatites, this according to Dr. Bryson. It is the uniform kaolinization of an alaskite granite intrusive that has produced the huge deposit. The mass averages about 15 percent kaolin. In the pit, as opened thus far, patches of feldspar and mica and other minerals are frequently met, as well as areas of the original alaskite in which the kaolinization has been retarded.

The deposit was prospected with shafts, tunnels and auger holes in the years 1931 to 1935. The tonnage disclosed is said to be sufficient to supply the plant for a century to come. From the shafts auger holes were drilled at intervals of 10 ft. for a distance of 150 ft. in four directions. In addition, the rest of the property has been prospected for feldspar and mica.

The Mining Method. Originally the company planned to work this deposit through a tunnel and surface gloryhole and to transport the ore to the plant on a belt conveyor. A 6x8-ft. tunnel, heavily timbered, was driven some 350 ft. before the idea was abandoned. It was run in an insufficiently kaolinized stratum that was taken as the bottom. At the time this work was stopped there was but 15 ft. of stripped clay above the heading and the overburden had been only 5 ft. deep. Decision was then made to work the deposit as an open pit.

The method used today is to strip with a power-shovel and trucks and to mine by scraping with a three-drum hoist and scraper into a centrally-positioned hopper that delivers onto a conveyor running out of the pit to the treatment plant. The scraper drags radially from all directions. In winter, unless the work is continuous, a crust requiring blasting will form quickly by freezing. The conveyor runs in the drift, partly uncovered, to the point where it starts up out of the pit.

Over the area now worked the overburden has averaged 10 ft. deep. In May, 1941, the stripped area was about 500x500 ft. in dimensions. Clay was being mined on about half of this 5- or 6-acre area. The kaolinized zone beneath the overburden is about 60 ft. deep.

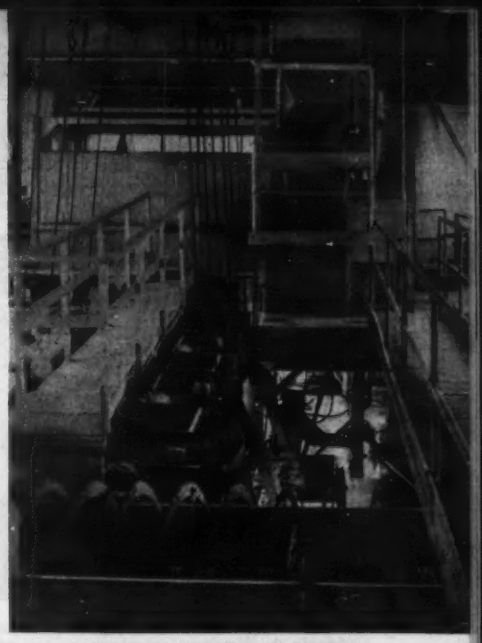
Stripping is done with a ¾ cu.yd. Austin-Western Badger shovel. This is gasoline-driven and caterpillar-mounted and loads into Marmon-Herrington 4-wheel-drive trucks which can take 3 cu.yd. without sideboards.

The scraping unit consists of a 3-drum I-R hoist driven by a 35-hp., 220-volt, 3-phase, 60-cycle G.E. motor, and a 1-cu.yd. Holcomb Westeeco hoe-type scraper weighing 1,300 lb. This has a manganese steel blade which is hard-faced. Wickwire preformed rope having an independent wire-rope center is used, the pull rope being ⅝ in. and the two tail ropes ½ in. Mascot sheaves with Life-Time bearings are used, the blocks being fastened to wooden dead men at the pit edge.

The conveyor framework is carried on small concrete piers in the drift. The belt, of Goodyear make, is 18 in. wide, 3 ply, with ⅛-in. and 1/32-in. rubber covering on top and underneath respectively. It is 1300 ft. long, or 450 ft. center-to-center.

In the Treatment Plant. Kaolin and mica are recovered separately, the latter by flotation. The entire plant, save for a minor addition to the mica plant, is of steel, concrete and glass. It was engineered by H. K. Ferguson Co., Cleveland, Ohio, save for the flotation and mica department, credit for which is due James A. Barr, Jr. The equipment housed is modern and the plant is a model for cleanliness and ship-shape order.

The mine conveyor, run by a 10-hp. G.E. motor and a Link-Belt speed-reducer, delivers into a Bartlett-Snow rolls disintegrator. Adjacent to the conveyor head pulley are two concrete constant-level tanks. One, of 3000 gal. capacity, contains processing water and here a deflocculating agent is added which keeps the kaolin in suspension until the impurities are removed. The other tank holds excess water from pumping.

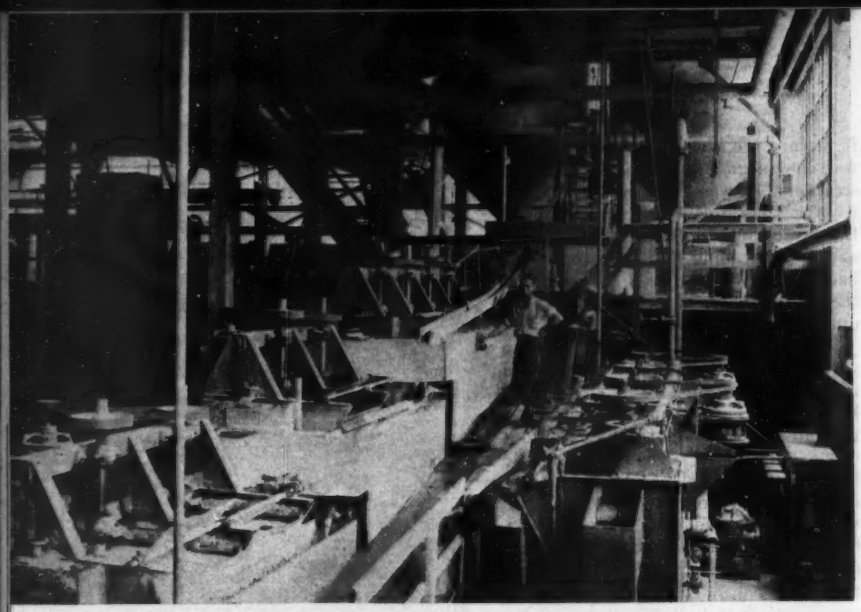


One of the two sections in the treatment plant. In the foreground is the sand reel; next a row of Niagara screens, and beyond these at the left is the blunger tank

The rolls-distintegrator, driven by a 25-hp. G.E. motor, has two rolls, one larger than the other and carrying knives set on its surface parallel with the diameter and projecting about an inch. These knives which are about an inch thick were formerly set in slots but are now welded on and built a little broader and heavier. The disintegrator, as its name implies, is designed to break up lumps and at the same time free the kaolin. No water is used here.

The discharge is split equally between two steel bins, each holding two hours' supply of crude clay. On the same floor are two constant-level tanks, 6x3x4 ft. deep, into which is split the processing water.

With the clay and the processing water thus split, the equipment that follows is also divided into two identical units, so far as the flowsheet is concerned. The clay from each bin, with the corresponding split portion of the processing water, goes to a blunger. This consists of equipment contained in a steel tank 18 ft. long and 10 ft. wide at one end, and 7½ ft. wide at the other, at one corner of which, at the wider end, the crude clay enters. Inside height is 7 ft. It contains three separate pieces of equipment for freeing the clay from its impurities, each piece being on its own shaft and all three shafts parallel with each other. The first, likewise the second, is a horizontal, round, steel shaft equipped with hubs to which are bolted curved knives, each 2½ ft. long, mounted radially on it at right angles to the shaft, suggesting



Floating the mica in the kaolin plant. Four products containing it, made in the course of freeing the clay from the accompanying minerals, are treated in these two machines. Left, the Minerals Separation machine. Right, the Denver Sub A. The concentrates go to the mica department

an evolution from the log washer. The shafts turn counterclockwise, the ends of the knives striking the surface of the clay-water mixture first. The feed drops into this tank at the end of the first set of knives. A baffle in the tank bottom between the first and second sets of knives and between the second set and the third piece of equipment yet to be described, causes the clay-water mixture to circulate from the first compartment to the second while it is being agitated by the knives, and so into the third compartment. The shaft in this, which is parallel with the other two, has mounted on it, at the end where the clay enters, three wheels separated from each other and about 6 in. wide, and bearing at equal intervals on the periphery 6 buckets which scoop up the coarse material from the bottom of the tank and discharge it at the top of each revolution into the compartment of the next wheel, in the case of the first two, and so to the third wheel. The third wheel delivers into a trommel having a 4-mesh screen and about 4 ft. long, also on the common shaft. Trommel oversize is discharged at the end into a stationary chute which leads either to the gravel bin or the sand conveyor. The undersize is delivered into the compartment of a fourth wheel like the first three, the buckets of which discharge this minus 4-mesh material, washed, from the blunger tank. Each of these four wheels as well as the trommel mounted on the common shaft runs in its own compartment formed by transverse partitions at the bottom. The fresh water enters the compartment of the fourth wheel, overflows into the trommel compartment and then successively into each of the three wheel compartments at the other end. Thus the cleanest water for washing is at the discharge, the next cleanest in the trommel compartment, and so on to the first wheel compartment at the opposite end. These bucket wheels serve to wash and scoop up the coarse material and deliver it to the next compartment having cleaner water.

On the periphery of each wheel between the buckets are mounted blades set on edge and at an angle to the shaft. These serve principally to work the coarse material into the buckets. Around the outside of the trommel is a spiral blade running its full length and revolving with it, so as to feed the trommel undersize forward to the discharge end.

The crude clay enters the tank at the end of the first set of knives. The clay suspension overflows at the middle of the 10-ft. end wall of this first compartment over a lip cut in the wall. The sand and gravel and other coarser material are discharged at the diagonally opposite corner of the tank, where the water enters, having received a thorough washing.

A 10-hp. motor runs the two sets of blunger knives and the shaft carrying the four wheels and trommel. The two shafts bearing the knives can be raised or lowered in the tank, a 2-hp. motor sufficing.

On each of the two units, the sand and gravel discharged from the blunger emerge split at 4-mesh. The plus 4-mesh finds use locally, most of it being sold. The minus 4-mesh sand is sized in an hydraulic separator where the fine sand fraction and most of the mica overflow. The settlings are then passed over a Plat-O table where the mica is separated from the sand and sent to flotation. The sand tailing goes to the dump, some being sold.

Blunger overflow (on each unit) is split between three single-deck Niagara screens, having 50-mesh screen or 70-mesh screen according to the product wanted. The screen oversize contains most of the mica and a small amount of sand and is sent to flotation. In the undersize is practically all of the clay, it being in suspension, plus some mica, feldspar, weathered alaskite and free silica sand.

Niagara screen undersize goes to the so-called sand reel contained in a 25x5-ft. tank which slopes slightly. It serves for washing, dewatering and conveying. In it there is at the feed end, in series, three bucket wheels like those in the blunger, followed by a revolving spiral that occupies the rest of the tank in the manner of a spiral classifier, wheels and spiral all being on a single shaft. The clay suspension flows away from the feed end, but the minus-50 or minus-70 material that settles travels on the bottom toward the feed end under the action of the spiral, at last reaching the three bucket wheels which give it an additional washing, the third discharging it. The sand goes to flotation for the separation of the mica. The clay suspension, plus the very finest sand and mica that has not settled, goes to a series of concrete settling troughs or sand boxes, each 7x30 ft. by 4½ ft. deep. There are 8 of these, serving the two units. The clay is run into a box for 5 to 7 hours, depending on the grade of the crude material.

Whatever settles out in these sand boxes, after a run, is sluiced out through a plug hole after stopping the feed. It is pumped to flotation.

The clay overflowing from the boxes is split between five 5-ft. rotary screens having 200-mesh cloth and each mounted on trunnions and driven by a ¾-hp. Gearmotor. Each has 24 ft. of screening surface. The plus 200 mesh oversize, consisting of mica and wood, is sent to waste. The clay suspension discharges into a launder where a flocculating agent is added and thence into one of eight 57,000-gal wooden settling tanks where the water is decanted. From this it goes at 30 percent solids by gravity into one of three 27,000-gal. mixing tanks of Douglas fir. The clay is now filtered.

Filtering is done in twelve Crossley presses with 24x24-in. frames, which discharge the cake at 70 percent solids. The cakes are knocked out onto a wagon underneath and are split in halves and the half cakes stacked on wooden rack cars, each capable of holding 220 half cakes on edge. These racks are run into a double-track tunnel dryer of brick, where the cakes are dried at 170 deg. F. to about 5 percent moisture, this taking 22 hours.

Cakes when dried are removed from the tunnel, thrown onto a grizzly to break them up, elevated to a belt conveyor which delivers to open storage, under cover, of 1250 tons capacity. Here the clay picks up a little moisture so that it runs about 7 percent when shipped.

A well-equipped control laboratory is provided. A representative analysis

of shipments is SiO_2, 46.18 percent; Al_2O_3, 36.38; Fe_2O_3, 0.57; TiO_2, 0.04; ZrO_2, 0.08; MgO, 0.42; CaO, 0.37; K_2O, 0.58; Na_2O, 0.10; and ignition loss, 13.28.

Analysis for grain size showed the following; 20 micron size, 5.9 percent of total weight; 20-15 microns, 1.4 percent; 15-10 microns, 3.7; 10-5 microns, 17.9; 5-3 microns, 13.3; 3-2 microns, 11.1; 2-1 microns, 11.7; 1-0 microns, 35.0 percent.

Other plant operating data are given in the accompanying table.

Clay is withdrawn for shipment on a belt conveyor through a loading tunnel and elevated to a loading bin. Shipments are usually made in bulk, although some clay is bagged for special customers.

Flotation of Mica. Four different products containing mica are made in treating the kaolin. These are sent to flotation machines in the main plant for recovering the mica. In the order of production, they are: (1) the concentrate from the Plat-O table; (2) the +50 mesh or +70 mesh oversize of the Niagara screens; (3) settlings from the sand reel; and (4) settlings from the sand boxes.

Two machines are provided: A No. 6 Minerals Separation Air Flow machine, installed in March, 1941, having eight 42x42-in. cells; and a No. 18 Special Denver Sub-A machine having six 32x32-in. cells and an 18-in. impeller. The latter was installed a year before. Reagents are not disclosed. The process is a soap flotation. Work is done under license from Phosphate Recovery Corporation.

Settlings from the sand reel and from the sand boxes are divided between the two machines, the Denver Sub A taking the former and the MS machine the latter. They are treated continuously, save when it is desired to treat the other two products. Then the settlings are stored in 7500-gal. tanks at 40 percent solids. The table concentrate is run on the MS machine, and the Niagara oversize on the MS. The grain size of the clay in this material is different from that of the clay in the settlings.

In the MS machine four of the eight cells are used as roughers, the tailings going to waste; two cells serve as cleaners and two as recleaners, the tailings of the four either going to waste also or being returned to the head of the roughers. Of the six cells of the Denver machine, three serve as roughers, two as cleaners, and one as a recleaner. Mica recovered in the froth is sent to the mica department.

The Mica Department. This is housed in a separate building. The mica pumped from the main plant is dewatered in a conical-bottomed steel tank and then dewatered further in a Fletcher centrifuge. From here it is discharged to a small wet storage bin from which an automatic variable-speed feeder feeds it into a Louisville steam-tube rotary dryer. In this the mica cascades around the tubes at a temperature of 260 deg. F. and is reduced to 1 percent moisture.

Dried, the product is elevated to a Howe scalper screen, the mesh ranging from 10 to 20. Oversize is put through a Prater pulverizer and returned to the elevator. Undersize is split between two double-deck Rotex screens, the meshes depending on the products to be made. Screen products are bagged in burlap on a Howe flour mill bagger.

The usual products, as designated in the mica trade, are No. 40 mica, which is coarse; No. 60 and No. 80, each finer than the preceding one; and No. 160, very fine. The last is 100 percent minus 40 mesh and will run 30 to 50 percent minus 200.

Plant capacity is said to vary from 1000 lb. to one ton of mica per hour, depending on the mesh.

Labor. The mine and both the main plant and the mica plant are working three 8-hr. shifts per day, five days per week. Five men per shift are employed on stripping, including one shovel runner, three truck drivers and one man at the dump. Two men additional are required in mining with the scraper. In the main plant, nine men per shift are required, including one in the head house where the ore is received, one on the sand boxes, one on flotation, five on pressing and drying the kaolin and one in the boiler room. In the mica plant four men are employed per shift in drying and screening. In addition, for the entire plant there is a superintendent and an assistant superintendent.

Power is obtained from the Carolina Power & Light Co. About 600 kw. is required. A power shortage looms, owing to the long prevailing drouth in the South and to the demands of the national defense program. Installation of a diesel plant is being considered.

Other difficulties arising from the current situation include a growing shortage of cars, this also being due to the need for moving defense materials. The draft, moreover, is beginning to draw upon the local man power, tending to create a scarcity of labor.

Since my visit, in May, the Harris Clay Co., which has several operations in western North Carolina, has leased the mine and plant just described from Kaolin, Incorporated, and is now running them.

Plant Products Made in a 24-Hr. Run

Figures based on actual measurements during a normal production at a flow of 18 liters/sec., 400 tons crude kaolin of average yield

Moisture	22.0%	88 tons
(1) Blunger gravel	1.5%	6 tons
(2) Blunger sand	30.0%	120 tons
(3) Vibrating screen mica	2.0%	8 tons
(4) Sandwasher sand	9.0%	36 tons
(5) Revolving screen mica	0.5%	2 tons
(6) Sandbox settlings	20.0%	80 tons
(7) Kaolin	15.0%	60 tons
	100.0%	400 tons

Mineral content of crude kaolin:		
Quartz	39.5%	158.0 tons
Mica	14.6%	58.6 tons
Feldspar	7.0%	28.0 tons
Kaolin	17.0%	67.8 tons
Water	21.9%	87.6 tons
	100.0%	400.0 tons

(1) Blunger gravel: + 4 mesh		
Quartz	60.0%	3.6 tons
Feldspar	20.0%	1.2 tons
Mica	10.0%	0.6 tons
Kaolin	10.0%	0.6 tons
	100.0%	6.0 tons

(2) Blunger sand: − 4 mesh		
Quartz	87.0%	104.4 tons
Feldspar	5.0%	6.0 tons
Mica	7.0%	8.4 tons
Kaolin	1.0%	1.2 tons
	100.0%	120.0 tons

(3) Vibrating screen mica:		
Mica	86.0%	6.9 tons
Quartz	10.0%	0.8 tons
Kaolin	4.0%	0.3 tons
	100.0%	8.0 tons

(4) Sandwasher sand: Sand reel		
Feldspar	20.0%	7.2 tons
Quartz	60.0%	21.6 tons
Mica	5.0%	3.6 tons
Kaolin	5.0%	3.6 tons
	100.0%	36.0 tons

(5) Revolving screen mica:		
Mica	33.3%	0.6 tons
Kaolin	66.7%	1.4 tons
	100.0%	2.0 tons

(6) Sandbox settlings:		
Quartz	40.0%	32.0 tons
Feldspar	20.0%	16.0 tons
Mica	33.0%	26.4 tons
Kaolin	7.0%	5.6 tons
	100.0%	80.0 tons

(7) Kaolin:	
Residues on 200 mesh	0.15%
325 mesh	0.85%
Cumulative 325 mesh	1.00%

(Mica includes micaceous kaolin and spar includes semi-decomposed kaolin)

Left, James A. Barr, Jr., superintendent and development engineer, Kaolin, Inc. Right, D. E. Jones, assistant to the president, Kaolin, Inc.

Summary of the

MARKETS

EFFECTIVE July 1, zinc was added to the list of non-ferrous metals under priority status. The reserve pool for emergency needs was continued on an unchanged percentage basis. Uncertainty about future imports of zinc concentrate was a factor in establishing the drastic controls. The copper industry was busy all last month in switching over to the control regulations announced in the prior month. Hearings took place in Washington to formulate price policy. It was announced that advisory committees are to be named for various strategic minerals to expedite the defense program.

Excepting tin and quicksilver, which sold at higher levels, quotations showed little change throughout June. The *E&MJ* index of prices for June was 83.51, against 83.48 in May.

Though price administrators still hope for a uniform 12c. Valley market for copper, the dual price situation remained in force last month. However, domestic copper averaged a shade lower for June. Export metal was unchanged. Deliveries of copper to domestic consumers during May totaled 141,801 tons, the largest tonnage ever shipped in a single month. Of this total, 49,190 tons consisted of metal of foreign origin released by Metals Reserve. Actual use of copper during May was estimated at 133,000 tons.

Substitution of lead for other metals and some "protective" buying by consumers resulted in an active demand for the metal. Talk of possible shipping difficulties in moving foreign ore and pig lead into this country made both producers and consumers apprehensive. The price structure in lead was strong, but the quotation continued at 5.85c., New York.

Zinc production is increasing, but with demands increasing steadily producers are rather discouraged about the outlook. Prime Western zinc has averaged 7.25c., St. Louis, for the ninth consecutive month.

Antimony was active on increased business in lead-antimony alloys. Quicksilver on spot was scarce and nominal quotations ranged from $185 to $188 per flask as June ended. Tin was higher on uncertainty about developments in the Far East.

UNITED STATES MARKET

1941 June	Electrolytic Copper: Domestic (a) Refinery	Electrolytic Copper: Export (b) Refinery	Straits Tin: New York	Lead: New York	Lead: St. Louis	Zinc: St. Louis
2	11.775	10.950	52.125	5.85	5.70	7.25
3	11.800	10.950	52.125	5.85	5.70	7.25
4	11.800	10.950	52.250	5.85	5.70	7.25
5	11.825	10.950	52.250	5.85	5.70	7.25
6	11.775	10.950	52.750	5.85	5.70	7.25
7	11.775	10.950	52.875	5.85	5.70	7.25
9	11.800	10.950	53.125	5.85	5.70	7.25
10	11.875	10.950	52.875	5.85	5.70	7.25
11	11.775	10.950	53.000	5.85	5.70	7.25
12	11.775	10.950	52.875	5.85	5.70	7.25
13	11.875	10.950	52.375	5.85	5.70	7.25
14	11.775	10.950	52.000	5.85	5.70	7.25
16	11.800	10.950	52.250	5.85	5.70	7.25
17	11.950	10.950	52.375	5.85	5.70	7.25
18	11.800	10.950	52.625	5.85	5.70	7.25
19	11.800	10.950	52.875	5.85	5.70	7.25
20	11.850	10.950	53.000	5.85	5.70	7.25
21	11.775	10.950	53.125	5.85	5.70	7.25
23	11.900	10.950	53.000	5.85	5.70	7.25
24	11.800	10.950	52.750	5.85	5.70	7.25
25	11.775	10.950	53.000	5.85	5.70	7.25
26	11.775	10.950	52.875	5.85	5.70	7.25
27	11.825	10.950	52.875	5.85	5.70	7.25
28	11.775	10.950	52.875	5.85	5.70	7.25
30	11.800	10.950	52.875	5.85	5.70	7.25
AVERAGES FOR MONTH						
June	11.810	10.950	52.685	5.850	5.700	7.250
AVERAGES FOR WEEK						
June						
4	11.815	10.950	52.175	5.850	5.700	7.250
11	11.804	10.950	52.813	5.850	5.700	7.250
18	11.829	10.950	52.417	5.850	5.700	7.250
25	11.817	10.950	52.958	5.850	5.700	7.250
CALENDAR WEEK AVERAGES						
June						
7	11.792	10.950	52.396	5.850	5.700	7.250
14	11.813	10.950	52.708	5.850	5.700	7.250
21	11.829	10.950	52.708	5.850	5.700	7.250
28	11.808	10.950	52.896	5.850	5.700	7.250

SILVER, GOLD AND STERLING EXCHANGE

1941 June	Sterling Exchange: "Checks" (Nominal)	Sterling Exchange: "90-day demand"	Silver: (c) New York	Silver: London	Gold: London	Gold: (d) United States
2	401.000	(f)	34.750	Holiday	Holiday	$35.00
3	401.000	(f)	34.750	23.4375	168s	35.00
4	401.000	(f)	34.750	23.4375	168s	35.00
5	401.000	(f)	34.750	23.3750	168s	35.00
6	401.000	(f)	34.750	23.3750	168s	35.00
7	401.000	(f)	(e)	(e)	(e)	35.00
9	401.000	(f)	34.750	23.3750	168s	35.00
10	401.000	(f)	34.750	23.3750	168s	35.00
11	401.000	(f)	34.750	23.3750	168s	35.00
12	401.000	(f)	34.750	23.3750	168s	35.00
13	401.000	(f)	34.750	23.3750	168s	35.00
14	401.000	(f)	(e)	(e)	(e)	35.00
16	401.000	(f)	34.750	23.3750	168s	35.00
17	401.000	(f)	34.750	23.3750	168s	35.00
18	401.000	(f)	34.750	23.4375	168s	35.00
19	401.000	(f)	34.750	23.4375	168s	35.00
20	401.000	(f)	34.750	23.4375	168s	35.00
21	401.000	(f)	(e)	(e)	(e)	35.00
23	401.000	(f)	34.750	23.4375	168s	35.00
24	401.000	(f)	34.750	23.4375	168s	35.00
25	401.000	(f)	34.750	23.4375	168s	35.00
26	401.000	(f)	34.750	23.3750	168s	35.00
27	401.000	(f)	34.750	23.3750	168s	35.00
28	401.000	(f)	(e)	(e)	(e)	35.00
30	401.000	(f)	34.750	23.3750	168s	35.00
AVERAGES FOR MONTH						
June	401.000	.....	34.750	23.400	....	35.00
AVERAGES FOR WEEK						
June						
4	401.000	.....	34.750	.....	....	.....
11	401.000	.....	34.750	.....	....	.....
18	401.000	.....	34.750	.....	....	.....
25	401.000	.....	34.750	.....	....	.....

Calendar week averages, New York Silver: June 7th, 34.750; 14th, 34.750; 21st, 34.750; 28th, 34.750.

(e) Not quoted (Saturday). (f) No quotation.

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Owing to the European War and the disruption of normal trade relations, our export copper quotations, since September, 1939, have been based largely on f.a.s. transactions, ex United States ports. To arrive at the f.o.b. refinery quotations deduct .05 from the f.a.s. basis for lighterage.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade Zinc delivered in the East and Middle West in nearly all instances command a premium of 1c per pound over the current market for Prime Western but not less than 1c over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly-mined domestic, by Handy & Harman. Under Treasury order of July 6, 1939, the price on domestic newly-mined silver mined subsequent to July 1, 1939, was fixed at 71.11c per troy ounce. Handy & Harman's quotation on newly-mined domestic silver, 999 fine was 70⅝c throughout June.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125.

LONDON MARKET

June, 1941	Tin—Standard—Spot	Tin—Standard—3 months Holiday
2		
3	264.750	265.000
4	265.000	265.000
5	266.250	266.000
6	268.250	268.250
9	268.500	269.000
10	266.000	266.750
11	266.000	267.000
12	264.000	265.750
13	260.750	262.750
16	261.750	263.750
17	263.250	265.000
18	264.250	265.500
19	263.000	265.000
20	261.500	263.750
23	261.250	263.750
24	260.500	263.000
25	259.500	262.000
26	257.500	261.000
27	257.000	260.500
30	256.000	260.000
Average	262.750	.....

Official tin prices on London Metal Exchange in long tons, pound sterling. Trading in copper, lead, and zinc suspended August 31, 1939.

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CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(July 1, 1941)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	17c.
Antimony, domestic, spot, lb	14.00c.
Bismuth, ton lots, lb	$1.25
Cadmium, commercial sticks, lb	90c.
Calcium, lb., ton lots 97 @ 98 per cent	Nominal
Chromium, 97 per cent grade, lb	89c.
Cobalt, 97 to 99 per cent, per lb	$1.50
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	27c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$36.00
Quicksilver, flask of 76 lb., 100 flasks or more	$185.00
Radium, mg. radium content	$25.00@$30.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$10.00
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50% Cr_2O_3 c.i.f. Atl. ports, long ton	(b)$43.00@$45.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$4.75
Mesabi bessemer	$4.60
Old Range non-bessemer	$4.60
Mesabi, non-bessemer	$4.45
Lead (Galena) 80 per cent, Joplin, Mo., ton	$69.58
Manganese Ore, (foreign) c.i.f. U.S. ports, long ton unit of Mn:	
52 @ 55 per cent	(b) 70c.
50 @ 52 per cent	(b) 70c.
46 @ 48 per cent	(b) 65c.
Molybdenum Ore, 90%, per lb. of MoS_2, f.o.b. mines	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	(b) $24.00
Domestic, 65 per cent and upward	(a) $23.50
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$48.00

(a) Prices at mines, small lots, usually several dollars less. (b) Nominal.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3½c
Cobalt Oxide, 70 @ 71 per cent, lb	$1.84
Copper Sulphate, 100 lb	$4.75
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.43
Sodium Sulphate, bulk ton	$18.00@$24.00

ALLOYS

Beryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$15.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, per pound of Cr contained	11c.
Ferromanganese, 78 @ 82 per cent, gross ton	$120.00
Ferromolybdenum 55 @ 65 per cent Mo. lb. of Mo. contained	95c.
Ferrosilicon, 50 percent, gross ton	$74.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.90@$2.00
Ferrovanadium, per lb. of V, delivered	$2.70@$2.90

NON-METALLIC MINERALS

Asbestos, f.o.b. Canadian (Quebec) mines (U.S. funds), ton:	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$49.50
Shorts	$13@$17.50
Vermont, f.o.b. Hyde Park:	
Shingle stock	$57.00@$60.00
Paper stock	$40.00@$48.00
Shorts	$13.00@$26.00
Floats	$18.00
Barytes, long ton:	
Georgia, crude	$8.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$6.50
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$7.00@$8.00
Domestic, abrasive, 80 @ 84 per cent	$14.00
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$20.00
Ground, 95 @ 98 percent, bulk, ton	$31.00
Lump, acid, 98 percent, bulk, ton	$27.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	45@60c.
2 x 2 in.	60@80c.
3 x 3 in.	$1.25@$1.50
3 x 4 in.	$1.50@$1.75
3 x 5 in.	$1.75@$2.25
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12c
Silica, in bags, 325 mesh, ton	$20.00@$40.00
Sulphur, Texas, mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.50@$10.50
Vermont, extra white, 200 mesh	$9.50@$10.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$24.50
Basic	$23.50
No. 2 Foundry	$24.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.15

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1940	1941	1940	1941	1940	1941
January	34.750	34.750	21.802	23.273	395.442	(a) 402.000
February	34.750	34.750	20.935	23.341	395.652	(a) 401.864
March	34.750	34.750	20.763	23.446	375.212	(a) 401.788
April	34.750	34.750	20.713	23.500	351.817	(a) 401.058
May	34.949	34.750	21.878	23.457	326.452	(a) 400.981
June	34.825	34.750	22.688	23.400	359.560	(a) 401.000
July	34.750	.....	22.095	.....	379.750	.....
August	34.750	.....	23.261	.....	396.889	.....
September	34.750	.....	23.446	.....	401.646	.....
October	34.750	.....	23.451	.....	401.692	.....
November	34.750	.....	23.238	.....	401.783	.....
December	34.750	.....	23.015	.....	402.000	.....
Year	34.773	.....	22.281	.....	382.325	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine, London pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents. (a) Nominal.

COPPER

	F.O.B. Refinery, Electrolytic			
	Domestic		Export	
	1940	1941	1940	1941
January	11.954	11.819	11.999	10.257
February	11.148	11.794	11.471	10.414
March	11.160	11.814	11.407	10.592
April	11.087	11.820	11.258	10.952
May	11.079	11.815	11.191	10.950
June	11.128	11.810	11.216	10.950
July	10.564	.....	10.189	.....
August	10.708	.....	9.851	.....
September	11.296	.....	9.849	.....
October	11.826	.....	10.436	.....
November	11.800	.....	10.084	.....
December	11.802	.....	10.293	.....
Year	11.296	.....	10.770	.....

New York quotations, cents per pound.

LEAD

	New York		St. Louis	
	1940	1941	1940	1941
January	5.471	5.500	5.321	5.350
February	5.076	5.602	4.926	5.452
March	5.192	5.765	5.042	5.613
April	5.071	5.850	4.921	5.700
May	5.015	5.850	4.865	5.700
June	5.000	5.850	4.850	5.700
July	5.000	.....	4.850	.....
August	4.854	.....	4.704	.....
September	4.929	.....	4.779	.....
October	5.308	.....	5.158	.....
November	5.726	.....	5.578	.....
December	5.500	.....	5.350	.....
Year	5.179	.....	5.029	.....

New York and St. Louis quotations, cents per pound.

TIN

	Straits, New York		Standard, Spot, London	
	1940	1941	1940	1941
January	46.707	50.154	240.716	256.648
February	45.851	51.293	242.833	264.975
March	47.079	52.067	251.711	270.131
April	46.815	51.981	252.080	269.775
May	51.570	52.166	264.098	267.534
June	54.618	52.685	273.438	262.750
July	51.591	.....	265.592	.....
August	51.176	.....	262.455	.....
September	50.348	.....	251.024	.....
October	51.490	.....	257.946	.....
November	50.577	.....	258.214	.....
December	50.101	.....	256.988	.....
Year	49.827	.....	256.425	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		
	1939	1940	1941
January	4.500	5.644	7.250
February	4.500	5.534	7.250
March	4.500	5.750	7.250
April	4.500	5.750	7.250
May	4.500	5.803	7.250
June	4.500	6.235	7.250
July	4.516	6.250	.....
August	4.719	6.389	.....
September	6.104	6.920	.....
October	6.500	7.250	.....
November	6.500	7.250	.....
December	5.980	7.250	.....
Year	5.110	6.335	.....

St. Louis quotations, Prime Western, cents per pound.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1940 (a)	1941 (a)	1940	1941
January	79.038	80.000	20.000	17.000
February	80.000	82.273	20.000	17.000
March	80.000	89.038	19.769	17.000
April	80.000	90.000	19.000	17.000
May	80.000	90.000	19.000	17.000
June	80.000	90.000	19.000	17.000
July	80.000	.....	19.000	.....
August	80.000	.....	18.000	.....
September	80.000	.....	18.000	.....
October	80.000	.....	18.000	.....
November	80.000	.....	17.522	.....
December	80.000	.....	17.000	.....
Year	79.920	.....	18.691	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound. (a) Producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1940	1941	1940	1941	1940	1941
January	14.000	14.000	156.962	165.846	40.000	36.000
February	14.000	14.000	178.000	170.182	40.000	36.000
March	14.000	14.000	180.921	177.692	40.000	36.000
April	14.000	14.000	173.538	180.077	38.923	36.000
May	14.000	14.000	181.538	180.000	38.000	36.000
June	14.000	14.000	197.360	183.920	38.000	36.000
July	14.000	.....	194.423	.....	38.000	.....
August	14.000	.....	184.111	.....	38.000	.....
September	14.000	.....	173.333	.....	36.167	.....
October	14.000	.....	168.846	.....	36.000	.....
November	14.000	.....	168.391	.....	36.000	.....
December	14.000	.....	164.960	.....	36.000	.....
Year	14.000	.....	176.865	.....	37.924	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk f.o.b Laredo, Tex., 13.000 for June. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum, per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1940	1941	1940	1941	1940	1941
January	23.50	24.50	22.50	23.50	23.00	24.00
February	23.50	24.50	22.50	23.50	23.00	24.00
March	23.50	24.50	22.50	23.50	23.00	24.00
April	23.50	24.50	22.50	23.50	23.00	24.00
May	23.50	24.50	22.50	23.50	23.00	24.00
June	23.50	24.50	22.50	23.50	23.00	24.00
July	23.50	.....	22.50	.....	23.00	.....
August	23.50	.....	22.50	.....	23.00	.....
September	23.50	.....	22.50	.....	23.00	.....
October	23.50	.....	22.50	.....	23.00	.....
November	23.50	.....	22.50	.....	23.00	.....
December	23.50	.....	22.50	.....	23.00	.....
Year	23.500	.....	22.500	.....	23.000	.....

Iron, dollars per long ton. F.o.b. Mahoning and Chenango Valley furnaces.

USEFUL OPERATING IDEAS

Low Amperage May Also Kill

DEATH OF A MAN through shock may be caused by that small amount of standard 60-cycle current which is less than the equivalent of the amperage used by a 15-watt 115-v. lamp. That is gleaned from test results which appeared in the February issue of *Electrical Engineering,* published by the American Institute of Electrical Engineers (p. 63, authors Charles F. Dalziel and John B. Lagen). Because time of exposure is an important factor, it is reasoned that any current which will cause a muscular reaction sufficient to prevent the person from letting go of the conductor is dangerous. Muscular reactions are always proportional to current and not to voltage.

Tests on 114 men taking shocks from one hand to the other with 60-cycle power showed that their average of the maximum let-go current was 15.5 milliamperes (0.0155 amp.). Some could let go with as much as 21.6 milliamperes and others could not let go above 9.7 milliamperes. From this it is reasoned that the fairly safe current a man can stand from one hand to the other is 8 to 9 milliamperes.

The authors say that the maximum current to produce ventricular fibrillation in man (heart muscles tremor or non-rhythmic beat which usually proves fatal) has been estimated to be about 100 milliamperes (0.1 amp.) for a duration of three seconds or longer. A 115-v. lamp of but 15-watt rating takes more than that—0.13 amp.

For direct current the authors venture to say that the safe current is at least 80 milliamperes. Heating rather than muscular contraction is the sensation when direct current is gradually increased after contact is established. Sudden changes of the current or breaking the circuit produced muscular contraction. Because men can let go of relatively higher d.c. currents, tests could be made only to find the limits of endurance at the let-go. On 28 men the limits were: average 74 milliamperes, minimum 61 milliamperes, and maximum 83 milliamperes.

According to the authors the tongue is the most sensitive organ likely to touch a live conductor and tests of contacts with that organ necessarily had to be limited to a determination of the minimum current perceptible—merely a matter of interest. The minimums, d.c., for 115 men were: average 44 microamperes (0.000,044 amp.), minimum 0.06 microamperes, and maximum 783 microamperes.

Relatively large currents, amperes not milliamperes, according to the authors, are necessary to destroy tissue and thus cause serious injury or death, although there may be no respiratory paralysis nor heart fibrillation.

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Glass Guard In Electric Shop

TO ELIMINATE the chance of an eye injury by flying particles, E. E. Rose, chief electrician of an Illinois fluorspar mining and milling company, wanted a guard for the electric shop utility grinder and desired that this guard be of a type permanently attached to the grinder because it is semi-portable and also that the guard be conveniently adjustable for any type of work. The answer was a no-draft section of a front window from a Chevrolet 1934 car and mounted as shown in the photograph of Mr. Rose demonstrating the use of the shielded grinder.

The main supporting bracket is pivoted on the base at a point back near the motor. Angle of that support is adjusted by a sliding brace extending to a pivot down on the base at the right-hand side. Angle of the glass frame in respect to the bracket is adjusted by another sliding brace on the left-hand side, but in this case the brace is from a pivot on the upper end of the glass frame, down to the adjustable slide on the bracket.

An efficient guard for a semi-portable grinder

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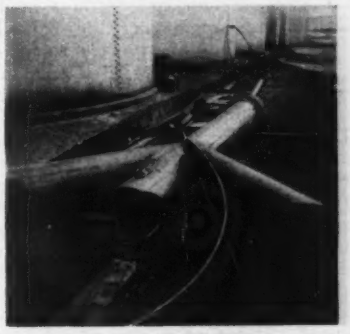
Chain Grate Stoker Feed Spout

RECENT PEAK OPERATIONS of a metal mine called for maximum performance of the company's steam-producing facilities. A study of the boiler-house operations with four 300-hp. Sterling water-tube boilers with chain grate stokers revealed that the operator did not have sufficient time to swing all the feed spouts from overhead bins to maintain a uniform bed of coal on the grates. When he left the spout at the center of the feed hopper over the grates the center of the bed always had plenty of coal, but an insufficient quantity was shown at the bed's edges.



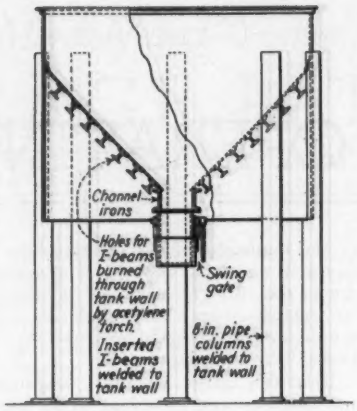
To remedy this condition, writes K. N. Banthin, mining engineer, we rebuilt one of the feeder spouts to form a three-way distributor, as shown in the attached photograph. Operation with this distributor did away with the necessity of a swinging spout and allowed the coal to enter the feed hopper at three points instead of one, to provide a uniform bed on the chain grates. This three-way distributor was constructed in the mine's own welding shops out of standard 12 in. pipe.

Possibly some other operator may be helped by these suggestions.

Steel Bin For Ore Storage

WHEN the management of Shattuck Denn Mining Corporation recently decided to reopen its concentrator at Lowell, Ariz., to handle a large tonnage of lead-zinc-copper ore developed in recent years, it was found that installation of storage facilities near the Denn shaft was necessary to assure steady flow of ore to the crushing plant bins. Accordingly, orders were given to the mechanical department to work out such a layout at the lowest possible cost, and E. L. Ingledue, master mechanic, solved the problem in the simple manner explained in the sketch, use being made of an old steel oil tank of 20½-ft. diameter.

Work involved removal of the tank bottom, followed by burning out


Channel irons
Holes for I-beams burned through tank wall by acetylene torch
Inserted I-beams welded to tank wall
Swing gate
8-in. pipe columns welded to tank wall

seven I-shaped holes in the tank wall on each side of the center line at an angle of 45 deg. by means of an acetylene torch to accommodate the different lengths of I-beam serving as supports or sills for the sloping bin floor. The I-beams next were carefully aligned, and then welded to the tank wall. Floor lining consists of steel plates bolted to the I-beam sills.

Stored material is withdrawn through a conventional swing gate at the end of a large hopper-shaped spout made from steel plate secured to the two channel irons at the bottom of the bin floor. The bin proper rests on seven 8-in. pipe columns welded to the tank wall as indicated.

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Five Dollars For Contributions

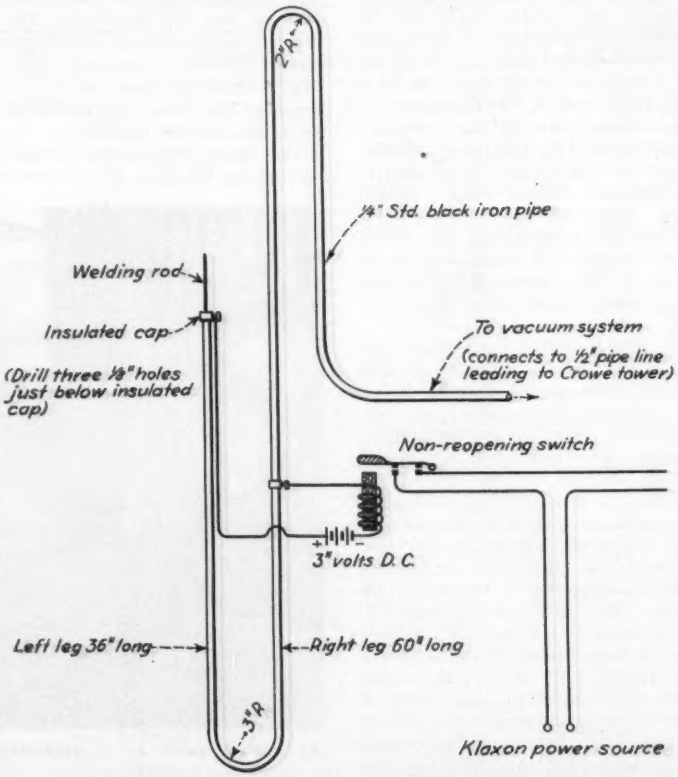
A MINIMUM OF $5 is paid for all Operating Ideas accepted for publication by E.&M.J. about electrical and mechanical kinks or shortcuts to profits as worked out in the field.

A Vacuum Alarm System

ALWAYS A CAUSE of concern to the operator of a cyanide plant employing the Merrill-Crowe precipitation process is maintenance of as perfect a vacuum as possible, writes D. L. King, mill superintendent, the Mountain Copper Co., Ltd., Matheson, Calif. To maintain a low precipitant cost and keep the resultant precipitate practically free from zinc, most operators hold the zinc feed to a possible minimum. Under such sensitive zinc control a nearly perfect function of the vacuum system is essential if barren solutions of lowest gold content are to be produced. Therefore, in case of a failure in the vacuum system, even to the extent of a 2-in. drop in vacuum (caused either by stoppage of the vacuum pump because of power or drive failure, clogging of a valve in the vacuum pump, sticking of the butterfly valve float shaft, or a leak in any part of the system, allowing air to enter), it is imperative that the operator be warned at once. To accomplish this, the Mountain Copper Co., Ltd., evolved and installed at its Iron Mountain cyanide plant, the signal system explained in the accompanying sketch.

As will be seen, a ¼-in. pipe line connects the ¼-in. standard black iron pipe U-tube with the Crowe tower (vacuum tank). The U-tube is filled with mercury, so that when vacuum is applied the mercury in the right leg will rise and fall a corresponding distance in the left leg. The length of latter is such as to make impossible an overflow of mercury when the system returns to atmospheric pressure.

On the right leg there is welded a contact post, and the left leg contains an insulated cap with an ⅛-in. hole and a setscrew-type binding post. In the ⅛-in. hole operates a piece of welding rod long enough to reach the level of the mercury when full vacuum is applied to the system. This rod can be adjusted and set to any point of vacuum, from perfect to atmospheric pressure. The two contacts are connected in series with an electro magnet and dry-battery system, with the magnet becoming energized when the mercury in the left leg of the U-tube makes contact with the welding rod electrode. Suspended above the magnet core, and connected to the arm of a single-pole,



single-throw switch, is an iron armature bar. When the magnet becomes energized the armature bar is pulled down on the magnet core, thereby causing the single-throw switch to close. This switch is also in series with the power source connected to the Klaxon. It is of the non-reopening type, and in case of a vacuum drop, if even for an instant, must be reset by the operator before the Klaxon ceases to blow. The system described will give warning of vacuum drops of as little as ¼ in. Cost of the installation is less than $10, exclusive of the Klaxon.

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Miner's Sturdy Eyebolt

WHERE heavy ground requires timbering, the electrical and mechanical repair men experience little trouble in locating a spot from which to sling a chain lift. However, in good ground where no cap piece is at hand, some other means must be found to rig up for the job of getting into the "innards" of a disabled locomotive, mucking or loading machine, or pump. Not always can the unit be readily hauled to the outside repair shop, as both time and local circumstances may require that the machine be put into service as soon as possible.

The illustration shows an eyebolt adapted from shaft-sinking operations, where it was used to anchor the lower end of a trolley guide cable from which the bucket was suspended by means of the trolley rigging. However, instead of driving the eyebolt into the side of the shaft, we electricians, states P. C. Ziemke, Milwaukee, Wis., drive them into the hanging wall or back of the drift. A stoper drill serves nicely to drive an 18-in. hole into the back, and on those occasions where no stoper is available a jackhammer does reasonably well. These holes are lined up with the center of the track, preferably a spur track so as not to interfere with haulage schedules, and a light charge of about ½ stick of 40 percent dynamite is lightly tamped and fired to spring the hole to give a chamber at the extremity of the bore.

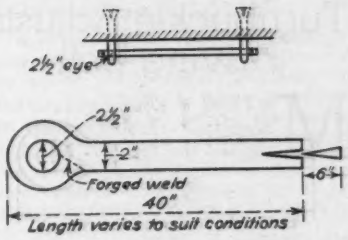
Developing a good chamber is essential, since the wedge end of the eyebolt then fully expands and fills the void so that it is practically impossible to pull the bolt out. Naturally, no hard and fast rule can be laid down as to blasting required.

Usually a spacing of 6 ft. is about right for the distance between eyebolts, a longer distance sometimes causing the suspended bar to sag. Bolt eyes are held at right angles to the track when being driven home, so that the bar may easily be fitted into each. Where sufficient headroom is available, a small trolley can be arranged as an added refinement if necessary.

In other places the hook of the chain fall can be placed directly on the bar, or the bar can be dispensed with and the hook placed directly in the eye, especially where no shifting of the lift is necessary.

A final requirement is that of securing the bar from shifting by drilling the ends for ⅝-in. bolts. These, when provided with nuts, definitely prevent end movement yet permit ready dismantling when a quick shift to another job is necessary.

In addition to being useful for repairs on locomotives and machines, car repair men find the arrangement convenient to upend or overturn mine cars for quick repairs to running gear. When the section of the mine so equipped is abandoned, bolts are usually left in place, though they can be salvaged by drilling a hole parallel to the eyebolts and blasting them.



Portable Slusher Ramp

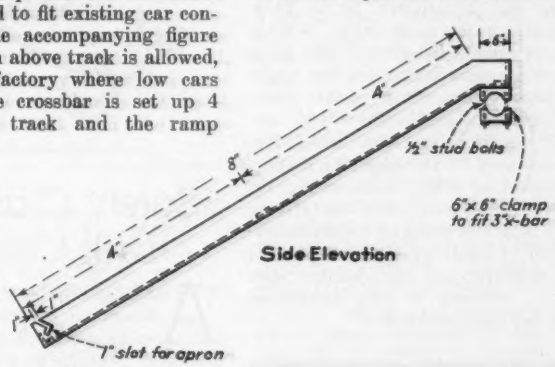
THE accompanying figure illustrates a simple, inexpensive portable ramp used in conjunction with small scraper-hoist units, designed and placed in operation at Naturita mine of Vanadium Corporation of America, by R. C. Bacon, mining engineer.

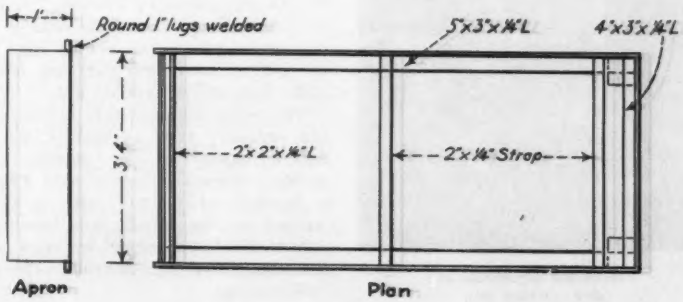
The framework is made of steel angle irons braced with 2x¼-in. straps at top and center, and all joints are welded. A 5x3-in. angle is used on the sides to support 2x12-in. side boards. The floor is laid between these side boards and consists of three 3-in. planks beveled at each end and separated by two pieces of 8-lb. rail. Thus wear on the floor is prevented.

The angle between the inclined portion of the ramp and the horizontal may be changed to fit existing car conditions. In the accompanying figure a 4-ft. elevation above track is allowed, which is satisfactory where low cars are used. The crossbar is set up 4 ft. above the track and the ramp clamps are centered on it. The hoist is also mounted on a bar behind and above the ramp, allowing the car to pass beneath it and to fit under the ramp. A 4-in. angle is used at the head of the incline to prevent dumping the scraper into the car.

The frame alone weighs 170 lb. and can be moved from one face to another by two men. The floor, side boards, and rails are transported separately and the apron is detachable. One half hour is ample time for two men to set up both ramp and hoist.

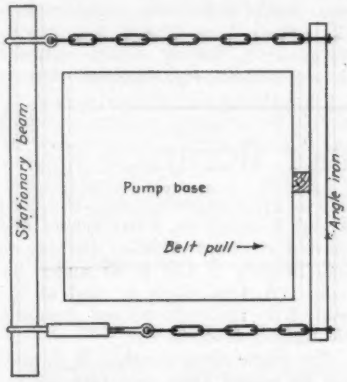
The entire cost of construction is less than $20. For a small operation where maximum portability and minimum capital outlay are imperative, this device will satisfactorily replace the more expensive mounted ramps.





Turnbuckle Adjusts Driving Belt

MOVING a 1,400-g.p.m. 400-ft. deep-well turbine pump to tighten the flat belt by which it is driven from a steam engine may have the aspects of a difficult job; but that it can be done by a simple arrangement is indicated by the accompanying sketch and photograph of the installation in a shaft of a large fluorspar mine in western Kentucky.



By hooking different links of the chain to the angle-iron and then adjusting the turnbucket an 8-in. travel is secured

The pump is driven by a 150-hp. Chuse non-releasing corliss engine which is in a building 40 ft. from the hoisting shaft. Belt width is 16 in. and its total length 96 ft. Proximate adjustment is made by hooking chain links to an angle-iron lever, then completing the adjustment by a 1½-in. turnbuckle in the other chain. A small block of wood constitutes the pivot between the pump base and the angle-iron lever. This arrangement allows an 8-in. adjustment. The 10-in. casing of the Pomona pump hangs free from a clamp 12 ft. below the driving head and that clamp slides along the supporting timbers when the driving head position is changed to tighten the belt. Drive shaft of this pump is 2½ in. in diameter and has stainless steel bushings working in water-lubricated rubber-bearing bushings.

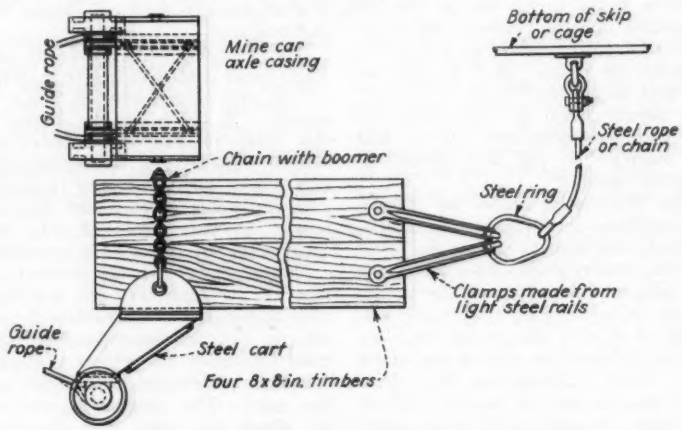
Turnbuckle adjustment of pump-driving belt

A Novel Timber Carrier

TO ATTAIN low haulage costs, materials must be delivered from the collar of a shaft to the point where they are required underground, with the least possible amount of loading and unloading. This applies particularly to one of the most important items needed underground —timber. At smaller properties, a direct delivery to the timber man is impossible because of lack of special transportation units, necessitating frequent unloading and reloading of the timber at various underground stations, with consequent loss of time and increased costs.

At the property of Banner Mining Co., near Lordsburg, N. M., of which E. S. Bowman is general superintendent, the problem was solved successfully by the use of an all-steel, two-wheel carrier as shown in the accompanying self-explanatory sketch. It consists of a sturdy frame made from steel plate, and two wheels operating in a conventional mine-car-axle casing. Auxiliary units include two clamps with a steel ring made from light rail, a short piece of chain or steel cable to attach the loaded carrier to the bottom of the skip or cage, a rope loop tied to the axle casing to guide the carrier, and a chain with boomer on the carrier proper to hold the timbers placed upon it. The clamps are attached to the timbers by two long steel bolts with wing nuts.

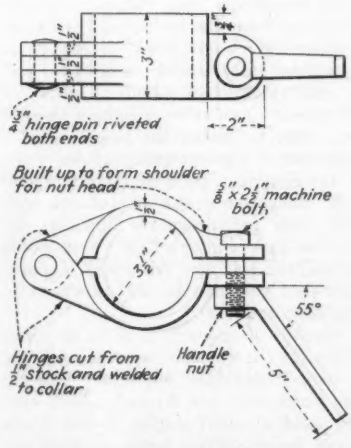
Usually four 8x8-in. timbers are lowered at one time. When completely prepared, the short piece of chain or steel cable on the ring of the two clamps is secured to the bottom of the skip or cage, with the carriage being guided into the shaft opening by the operator holding the rope loop while the hoist man slowly raises the skip or cage. At the designated shaft station underground, the attendant first gets hold of the rope loop and then pulls the carriage onto the station platform while the hoist man slowly lowers the skip or cage.



Safety Clamp for Drill Column

A DRILL COLUMN safety clamp which can be built in any blacksmith's shop has been devised by C. R. Nichols, of El Dorado Limestone Co., Shingle, Calif., as shown by the accompanying drawing. A ¼x3-in. piece of steel forms the sides of the clamp, to which are welded lugs for the hinge and clamp carrying a machine bolt and a handled nut.

The advantage of this clamp over the ordinary type is that it can be moved easily on the column. No monkey wrench or special end wrench is needed and a tap with a chuck wrench on the handle nut loosens it sufficiently to be turned by hand, and the clamp quickly positioned on the drill column.


hinge pin riveted both ends
2"
Built up to form shoulder for nut head
⅝" x 2½" machine bolt
55°
Hinges cut from ½" stock and welded to collar
Handle nut
5"

Diagrammatic detail of safety clamp for drill column

PERSONAL ITEMS

G. G. Bowser is president-elect of the Mining Society of Nova Scotia.

Eugene H. Dawson has left New York for Mexico on professional business.

A. O. Dufresne has been appointed deputy Minister of Mines for the Province of Quebec.

George R. Gibson, field engineer for Hollinger Consolidated Gold Mines, Ltd., has taken up residence in Vancouver.

M. W. Hotchkin, manager of Toburn Mines, Ltd., has been reelected president of the Ontario Mining Association.

J. A. Randall, mining engineer of Wilcox, Ariz., has gone to Potosi, Bolivia, with the Cia. Unificada del Cerro de Potosi.

C. W. Gudgeon, formerly manager of Sesame Gold, Batlow, New South Wales, has been appointed an inspector of mines in that State.

J. G. Woolcock has been appointed general manager of Consolidated Gold Areas, N. L., Western Australia, succeeding **J. G. Bremner.**

Phillip A. Ringulet, formerly mill superintendent for El Dorado Crystal mine, is now mill foreman for Log Cabin Mines Co., at Leevining, Calif.

S. Power Warren has taken charge of a new 100-ton tungsten mill at the property of the Golconda Syndicate, Golconda, Humboldt County, Nev.

Walter F. Brown, formerly general superintendent of Sisco Gold Mines, is now manager of Broulan Porcupine Mines, Ltd., and of Bonetal Gold Mines, Ltd.

Dr. C. H. Desch was recently awarded the 1941 Institute of Metals medal of the Institute of Metals, Oxford, Engd land, for "Distinguished services to nonmetallurgy."

Alex. Colledge, who has been in charge of tantalite mining operations in Western Australia, has been appointed general manager of Renison Associated Tin Mines, N. L., Renison Bell, Tasmania.

George L. Cornwall recently became mill superintendent for Sand River Gold Mining Co., at Beardmore, Ont. He was formerly with Cariboo-Hudson Gold Mines, operating near Barkerville, B. C.

A. G. Roach, formerly mill superintendent for Seal Harbor Gold Mines, at Goldboro, N. S., has accepted a similar position with Jerome Gold Mines, in Ontario, which is erecting a 500-ton mill.

Grover Kihorny, with interests in scheelite properties near Bishop, Calif., and from whom **E. L. Cord** recently acquired tungsten claims at Darwin, now producing, lately investigated Nevada deposits.

Fred H. Lenway has been checking on available sources of quicksilver and tungsten in Nevada mining centers for the Mercantile Metal & Ore Corp., of 67 Broad St., New York.

E. C. Bitzer has resigned his position as superintendent of the mill of the London Mines & Milling Co., at Alma, Colo., to become a sales engineer for the Colorado Iron Works.

E. B. Webster, formerly a mining engineer in British Columbia and more recently Inspector of Mines in Saskatchewan, is now retired and living in Vancouver.

Dr. Arthur S. Adams has been appointed assistant dean of the College of Engineering at Cornell. Dr. Adams came to Cornell a year ago from the Colorado School of Mines.

John M. Davis has resigned as Eastern manager for Denver Equipment Co. to devote his time to mining interests in Venezuela and New Mexico. He will maintain headquarters in New York City.

Harry L. Egolf, Jr., who has been with Cerro de Pasco Copper Corp. for the past three years, is returning to the United States and can be reached at 2803 N. Broad St., Philadelphia, Pa.

Edward Wisser, consulting geologist, has returned to his office in the Call Building, San Francisco, Calif., after an extended stay at Johns Hopkins University, Baltimore, Md.

Lewis Lewis, formerly of the metallurgical staff of The Broken Hill Associated Smelters, Port Pirie, South Australia, has joined the staff of the Council for Scientific and Industrial Research, Melbourne, Victoria.

H. H. Barrows, manager of the tungsten mines division of the General Electric Co., has been in Nevada districts after visits to properties his company is operating in Montana, Idaho and Arizona.

Prof. Charles E. Locke will this year retire from the faculty of the Massachusetts Institute of Technology, with the rank of professor emeritus. He has served on the staff of M.I.T. for 40 years.

Ira B. Joralemon, of San Francisco, president of the Summit King Mines, Ltd., subsidiary of Bralorne Mines, Ltd., lately inspected the Dan Tucker mine and improved cyanide mill of his company at Sand Springs, Churchill County, Nev.

O. W. Ellis, director of the department of engineering and metallurgy of the Ontario Research Foundation, was awarded the Plummer medal at the recent annual meeting of the Engineering Institute of Canada.

R. Playter, who has been geologist to Lake View and Star Ltd., Kalgoorlie, for eleven years, recently left Australia for the United States, where he will act as consulting geologist to the various undertakings of New Consolidated Goldfields, Ltd., in North and South America.

Carlos Wark, Jr., has resigned as superintendent of the Adelaide-Crown mine, in southeastern Humboldt County, Nev., and is employed by the American Cyanamid Co. at Stamford, Conn.

Sylvester C. Buchanan has been in the employ of the Guanajuato Consolidated Mining & Milling Co. at Guanajuato, Mexico, since leaving San Felipe de Hijar, in the State of Jalisco, last March.

Charles Robert Julian, of the London Institute of Mining and Metallurgy, was recently awarded the Consolidated Goldfields of South Africa Ltd. gold medal for his paper on "Underground Mining at Rio Tinto, Spain."

J. J. Strutzel, for some time staff engineer with Greenan & Co., Inc., with Reno headquarters, was reported to be investigating manganese deposits in Pershing and Humboldt counties, Nev., for Cuban-American Manganese Corp.

Walter R. Storms, general superintendent for Elizalde & Co., Paracale Camarines Norte, P. I., and Mrs. Storms are spending six months vacation in the United States. Their address is 35 W. Portland St., Phoenix, Ariz.

Frederic Benard, assistant to the general superintendent of the mining and smelting division of the International Nickel Co. of Canada, Copper Cliff, Ont., was recently awarded the platinum medal of that company by the Canadian Institute of Mining and Metallurgy.

Dr. W. G. Woolnough, geological adviser to the Commonwealth of Australia, has resigned. He has been succeeded by **Dr. H. G. Raggatt,** who has been acting as assistant adviser for some time. Dr. Raggatt was previously on the geological staff of the Department of Mines, New South Wales.

E. J. Hergenroether, metallurgist, of the Detroit field office of the Development and Research Division of The International Nickel Co., Inc., has resigned to join the staff of the Conservation Section, Production Division, of the Office of Production Management.

A. J. Harris has resigned the position of mine manager of Golden Carshalton, N. L., Bendigo, Victoria, owing to ill-health. **H. F. Pearson,** who not long ago came to Bendigo from Chewton as manager of Golden Transverse, N. L., succeeds him.

F. W. Cuthbert, associated with North Queensland mining for many years, who was responsible for reopening the mine on Misima Island, Papua, now known as Cuthberts Misima, has been in Melbourne recently securing machinery for the Golden Bar mine, Georgetown, North Queensland.

Jay A. Carpenter, director of the Nevada State Bureau of Mines and of the Mackay School of Mines, a depart-

ment of the University of Nevada, has been heading a field trip of engineer students to numbers of Nevada mining districts, annual vacation-time trips having been provided for by the S. Frank Hunt Foundation.

H. R. Banks has been appointed superintendent of all operations at the Sullivan mill at Chapman camp, Kimberley, B. C., and **Stanley Gray** has been made superintendent of all mills other than the Sullivan operated by the Consolidated Mining & Smelting Company of Canada.

N. A. Veitch, after some years' absence in the Rhodesias, is reported to have returned to Johannesburg and is practicing privately as a consulting metallurgist. He has recently been engaged in modernizing the treatment plant of the Globe and Phoenix mine at Que Que, Southern Rhodesia.

Elgin B. Holt, whose position as district engineer for the Arizona State Department of Mineral Resources ceased June 15, because of the veto of Governor Osborne to the budget appropriation for the conduct of the department, will engage in private engineering work in future. His address is: P. O. Box 288, Kingman, Ariz.

Dr. Hugh McKinstry, consulting geologist and member of the faculty of the University of Wisconsin, was in the Coeur d'Alene district recently for the purpose of studying the geological conditions at the Sunshine Consolidated property on Big Creek, which was the scene of a much-heralded silver strike a few weeks ago.

C. V. Brennan, for many years assistant general manager of Britannia Mining & Smelting Co., Ltd., Britannia Beach, B. C., Canada, subsidiary of Howe Sound Co., has been transferred to the staff of the parent company. Mr. Brennan, who some years ago obtained and developed the Chelan copper-gold property at Holden, Wash., will devote his efforts to general exploration and development work. His headquarters will be at 2430 Monte Vista Place, Seattle, Wash.

R. C. Allen, ferrous minerals consultant in the materials branch, production division, O.P.M., has been granted an indefinite leave of absence to return to his position as executive vice president of Oglebay, Norton & Co., of Cleveland, Ohio. Mr. Allen joined the National Defense Advisory Commission as consultant on manganese and chromite soon after it was established last year. He later became consultant on all ferrous minerals under the Office of Production Management.

Dr. Ernest M. Hopkins, chairman of the Minerals and Metals Group, Priorities Division, O.P.M., has resigned that post in order to return to his duties as president of Dartmouth College, where he has just celebrated his twenty-fifth anniversary as president. Dr. Hopkins, who served during the World War as assistant to the Secretary of War, in charge of industrial relations, joined the staff of the Priorities Division in January.

W. P. Netzeband has accepted a position as mining engineer in the Joplin office of the American Zinc, Lead & Smelting Co. Previously, Mr. Netzeband was superintendent for the Silica Products Co. at Batesville, Ark. He formerly was statistician for the Tri-State Zinc and Lead Ore Producers Association for several years.

Francis T. McGuire, who has been Teaching Fellow in the department of metallurgy at the University of Notre Dame for the past two years, received the degree of doctor of philosophy at the June commencement. Immediately thereafter he assumed his duties as assistant professor of metallurgy in the University of Kentucky, Lexington, Ky. Mr. McGuire received his bachelor's degree at Notre Dame in 1936 and his master's degree in 1938. After spending one year in graduate work at Harvard University he returned to Notre Dame to complete work for his doctorate.

▼ ▼ ▼

OBITUARY

Harry P. Dickenson, a retired mining engineer of Prescott, Ariz., died on June 14 at the age of 76.

Byron G. Shell, well-known Arizona mining man of Prescott, Ariz., died in that city last month. He was 74.

Sir Charles Fielding, formerly chairman of the board of the Rio Tinto Company, and active in the service of his country in the first World War, died in England on April 9 at the age of 77.

Kenneth Baring Taylor, of the British firm of John Taylor & Sons, mining engineers, died recently in England. He was 50. He was known in the Kolar gold field, in India, and in Burma and Canada.

Lloyd Dix Cooper, for 20 years general manager of E. J. Longyear Co., and widely known in mining circles, died suddenly in Minneapolis on Mareh 23, 1941, at the age of 63.

John Gillie, long associated with Anaconda Copper Mining Co. as general superintendent and consulting mining engineer, died on June 8 at Butte, Mont., at the age of 82.

Dr. Keith Moore died in Perth, Western Australia, on March 1. Dr. Moore had been in charge of the Commonwealth Health Laboratory in Kalgoorlie for ten years and was a leading authority on the subject of silicosis and other industrial diseases.

W. G. Clarke, who died on March 9, was research metallurgist at the School of Mines, Kalgoorlie. He had a high reputation in metallurgical investigation and had been associated with the treatment problems of many of Australia's largest mining undertakings.

Ing. Javier Sanchez Mejorada, director of the Mexican Mining Association, in Mexico City, died on May 23 at the age of 55. Señor Sanchez Mejorada, before becoming associated with mining, held various important positions in Mexican Government circles, including a diplomatic appointment on the Continent.

Dr. W. S. Dyer, prominent Canadian geologist, died in Toronto on June 4. Following graduation from the University of Toronto he joined the staff of the Ontario Department of Mines and took charge of extensive exploration of lignite at Blacksmith Rapids on the Onakawana River. His report on the Moose River Basin was recognized as a major contribution to the literature of the James Bay Coastal Plain. In recent years he had maintained an office in Toronto as consultant.

Clifford T. Oughtred, superintendent of concentration for the Consolidated Mining & Smelting Co. of Canada, Ltd., was killed on May 22 in an automobile accident near New Denver, B. C. Shortly after the last war, Mr. Oughtred was made superintendent of the customs concentrator at Trail. In 1925 he became superintendent of the Kimberley concentrator. In 1928 he became superintendent of all concentration operations for the company.

Waldo Lee Clark, of Grossmont, Calif., died at Naval Hospital, San Diego April 4, 1941, age 48. He was a longtime resident of Grossmont at El Granite and Sunset. Mr. Clark was a native of Grants Pass, Oregon, had his early schooling in Oakland and entered the University of California in Berkeley. He left there to serve with an engineering regiment in the World War, winning the Distinguished Service Cross for his work in France.

William Guggenheim, a member of the distinguished mining family, who severed his connection with the family firm in 1901, died in New York on June 27. He was 72 years old. Born in Philadelphia, William Guggenheim prepared himself to enter the family firm with a degree from the University of Pennsylvania in metallurgy and chemistry in 1889. Like several of his brothers, he was sent to Colorado to serve his apprenticeship and became superintendent of the Philadelphia Smelting and Refining Company, of Pueblo. From 1891 until his retirement in 1901, when the firm was consolidated with the American Smelting and Refining Company, he was general manager for M. Guggenheim's Sons in Mexico. Later active in alumni affairs of the University of Pennsylvania and in societies dedicated to the memory of its founder, Benjamin Franklin, he became honorary president of the International Benjamin Franklin Society, trustee of the Italy America Society, and a member of the American Chamber of Commerce in France, Museum of the City of New York, American Museum of Natural History, Metropolitan Museum of Art, Academy of Political and Social Science, General Alumni Society of the University of Pennsylvania and American Society of the Royal Italian Orders. He was entitled to membership in the last group by virtue of a decoration as Commander of the Order of the Crown of Italy. Mr. Guggenheim sent a cable message to Adolf Hitler in 1939 in an effort to stop the European war. In 1940 Mr. Guggenheim, who was honorary chairman of the army and navy committee of the American Defense Society, returned to the Italian government the decoration Commendatore dell'Ordine della Corona d'Italia, which had been conferred upon him in 1920.

What Metal Statistics Show

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922–3–4)

1929	110.33	1935	74.66
1930	82.87	1936	73.45
1931	60.20	1937	90.86
1932	48.26	1938	73.67
1933	59.79	1939	77.71
1934	69.59	1940	79.22

	1939	1940	1941
January	77.12	80.85	82.48
February	76.89	77.23	82.76
March	77.00	77.94	83.27
April	74.79	77.19	83.48
May	73.61	77.68	83.48
June	73.17	78.85	83.51
July	71.95	76.72	....
August	73.88	76.71	....
September	83.07	79.40	....
October	84.25	82.49	....
November	83.80	83.14	....
December	82.89	82.42	....

PROBLEMS of the copper industry under the control measures now in force were discussed in late June and early July among officials of the industry and the Government. There was some talk of the Government's intention to take full charge of distribution of copper commencing with August. The industry hopes that such action may yet be averted.

The possibility that the Government may enter the picture as a buyer and pay a premium or subsidy to small high-cost producers was considered in June. Arizona miners suggested that 14c. would bring in a good tonnage not available in a 12c. market. Leon Henderson told a House Appropriations Committee that owing to the shortage in copper supplies a higher price will have to be allowed high-cost mines in Michigan, and action is expected soon.

It is believed that the percentage of copper to be set aside for the July pool will be the same as that imposed for June, namely 20 per cent of domestic production.

With labor troubles at fabricating plants less of a factor, deliveries of copper in this country expanded during May to the record high of 141,801 tons, the latest statistics of the Copper Institute show. Of this total, 49,190 tons consisted of foreign-origin metal.

Stocks of refined copper (duty-free) declined 3,221 tons during May to 95,568 tons. Combined stocks of duty-free and foreign metal are not shown in the monthly statistics.

Production of duty-free crude or blister copper increased from 88,042 tons (corrected) in April to 90,292 tons in May. Stocks of blister increased 902 tons during May.

A summary of the domestic figures for April and May, in tons, follows:

	April	May
Production:		
Crude	(a)88,042	90,292
Refined	(a)89,682	89,390
Deliveries, refined (b):		
Domestic customers	123,580	141,801
Export	49	.....
Totals	123,629	141,801
Stock at end, refined (c)	(a)98,789	95,568

(a) Corrected. (b) Includes delivery of duty-paid copper for domestic consumption (Metals Reserve Company acquisitions). (c) At refineries, on consignment and in Exchange warehouses. Does not include copper at consumers' plants or warehouses.

►LEAD—The May statistics on lead refined in this country showed that stocks were reduced 8,881 tons. Production increased, but at the same time the industry was confronted with larger demands for the metal from consumers. Deliveries by domestic refineries totaled 69,382 tons for the month of May, a new high for the movement. The statistics disclose that domestic consumers will have to rely more than ever on imports of pig lead from various foreign sources to relieve the situation.

Statistics covering lead refined in this country for the months of April and May, in tons, according to the American Bureau of Metal Statistics, follow:

	April	May
Stock at beginning	45,996	42,899
Production:		
From domestic ore	43,423	46,104
Secondary and foreign	12,663	14,405
Totals	56,086	60,509
Domestic shipments	59,169	69,382
Stock at end	42,899	34,018

The Government is negotiating to import pig lead from Canada, Mexico and Peru. Details concerning the deal are expected to be announced during July. The trade believes this action should relieve the supply situation materially.

►MOLYBDENUM—Demand for molybdenum is expected to show marked expansion this year, owing to the need for conserving other minerals, as nickel and tungsten. OPM has directed consumers of tungsten steel to divert 50 percent of their requirements into molybdenum-type steel.

Domestic Slab Zinc Statistics

(American Zinc Institute)

Domestic zinc statistics, covering all grades, for the first five months of 1941, in tons:

1941	Stock at Beginning	Production	Prod. Daily Rate	Total Shipments	Export (a)	Stock At End
January	12,884	60,414	1,947	63,272	.....	10,026
February	10,026	(b)56,227	2,011	(b)59,168	.....	(b)7,085
March	(b)7,085	63,390	2,044	(b)63,425	.....	(b)7,050
April	(b)7,050	(b)63,210	2,110	(b)62,974	.....	(b)7,286
May	(b)7,286	(b)64,645	2,086	(b)63,604	1,192	8,327
June	8,327	62,236	2,075	63,159	1,254	7,404

(a) Exports included under total shipments. (b) Corrected.

The statistics of the Prime Western division, included in the totals covering all grades, indicate that stocks of common zinc at the end of June amounted to 4,294 tons, against 3,628 tons a month previous. The Prime Western group produced 25,991 tons during June, against 27,657 tons in May. The quantity shipped during June was 25,324 tons, against 27,158 tons in May.

United States Tin Imports

Imports of tin into the United States in ore and as pig tin for 1940 and the first four months of 1941, in long tons, as compiled from official records by the American Bureau of Metal Statistics:

	Jan.-Dec. 1940	Jan. 1941	Feb. 1941	March 1941	April 1941
Tin ore (content)	3,048	323	70	204	2,459
Argentina	288	...	...	...	102
Bolivia	2,300	288	70	170	2,330
Mexico	346	28	...	26	9
Portugal	52	...	...	8	...
Other countries	62	7	...	...	18
Tin pigs, bars, etc	124,825	12,055	9,836	13,896	15,246
French Indo China	1,241	...	...	...	...
Australia	711	40	90	45	50
Great Britain	4,850	325	858	242	1,374
China	3,889	40	39	31	15
Hong Kong	480	...	...	...	...
Netherland Indies	12,102	878	954	1,035	1,885
British Malaya	96,469	9,267	6,995	12,243	11,122
Belgian Congo	4,898	1,505	900	300	850
Other countries	185	...	...	...	...

It Happened in Sixty-Six

Engineering and Mining Journal was established 75 years ago in April as the American Journal of Mining. Our anniversary will not be celebrated, however, until next month, when we shall publish a Diamond Jubilee issue of E.&M.J. In the meantime, we have reprinted each month a few selected items from Journals of 75 years ago. The following are culled from the issues for July 1866.

New Route to Idaho

A new company has been organized in California to run stages and wagons—for transportation of passengers and fast freight—from the town of Chico, Butte County, to Boise city, Idaho. The general route is from Chico, via Susanville, Ruby city, to Boise. The amount of capital stock is $200,000, in shares of $100. The principal place of business, and the business office of the Company is to be located in San Francisco, and the place of active business to be in the town of Chico, Butte Co., California. The San Francisco *Flag* thinks that the successful opening of this long contemplated route from California to the mining districts in Idaho and Montana will form a new era in the public enterprise of the day.

Nitro-Glycerine Triumphant

While the continent stood aghast at the news of the terrible explosions of nitro-glycerine at Panama and San Francisco, which recently occasioned such deplorable losses of life and property, nearly the entire American press—and particularly those papers devoted to science—were either violent in their denunciations of the new and mysterious explosive, or preserved a politic silence. We believe that the *Journal of Mining* was the only scientific paper in America that came right out, and boldly defended the continued use of this invaluable adjunct in mining enterprises, at a time when it was feared that public opinion would forbid it. We then predicted that nitro-glycerine could not be "put down," and that prediction has already been triumphantly vindicated. After the successful public experiments recently made at Washington, in the presence of President Johnson and a large concourse of scientific men, the Committee on Trade and Commerce witnessed a further series of experiments which proved equally satisfactory. The result is, that a bill has been passed amending a previous prohibitory bill, and providing for the transport of nitro-glycerine under proper precautions.

Improved Ore-dressing Machinery

Mr. John Hunt, of Porthleven, England, has invented a new ore-dressing machine, working on the principle that the varying specific gravity of different minerals, will cause them, when raised in water, and held for a short time in suspension therein, to settle down separately according to their respective weights. His machine, by a sudden pressure, causes water to pass up through a perforated table, on which ore—say ore containing lead, copper, and refuse—is placed. The pressure of the water raises the ore, and as it is carried by the water from the feeding to the discharging part of the machine, the lead sinks in a compartment nearest the feeder, the copper is carried into the next compartment, and so on. It is said that the machine is applicable not only to the treatment of ordinary ores, but also alluvial gold or crushed quartz; and so delicate is the action that it will not only save fine gold, but precious stones, such as diamonds, sapphires and rubies, which are frequently mingled with alluvial gold.

Mineral Statistics

We have long been of the opinion that a Bureau of Mines should be created in the Treasury Department, and hence are glad to learn that an amendment to the Civil Appropriation bill, "appropriating $15,000 to enable the Secretary of the Treasury to collect statistical information about the mineral resources of the Pacific States and Territories," recently offered by Senator Conness, was adopted. This is a step in the right direction—a short one to be sure, but still a step. But had the amount of appropriation been $100,000 instead of $15,000, and *all* the States and Territories included, instead of simply those on the Pacific, we should have been much better pleased. What were the Senators from Michigan, Illinois, and Wisconsin, thinking of when they allowed their States to be passed by? and those of Pennsylvania, Missouri, Ohio, and other States, rich in minerals? Surely nothing could be more essential to a full measure of national prosperity than the establishment of a Bureau for the collection of statistics of the products of gold, silver, copper, iron, lead, tin, and other metals, or their minerals—those products that have so important a bearing upon the industrial wealth of the entire country. The next session, Congress, we trust, will attend to this matter.

Granulation of Blast-Furnace Slags

For the past two years the granulation of blast-furnace slags has been successfully accomplished in France, the whole of the inconvenience usually arising from the accumulation of masses of vitreous matter being thus avoided. The slag is simply permitted to run into water instead of running upon the ground as usual. The water used is the waste from cooling the tuyeres, &c. A suitable pit is formed to receive the water, and the molten slag is run through a gutter into it—of course, becoming finely divided and friable. The slag-sand is raised by an endless chain of buckets, and removed in carts, or otherwise. It is useful for making mortar and silicious bricks, as well as for agricultural and a variety of other purposes. The invention of the process is due to Mr. Minary, and may be seen in use at the works of the Franche-Compte Forges Company, in the department of Jura. The sands vary in color from dingy-grey to dark brown or black and weigh about 1200 kilogrammes the cubic metre.

Nomenclature of Mining Districts

If American miners were to be judged by the nomenclature prevalent in our mining districts, what singular notions concerning them would enter the minds of people who have never seen a mining camp, or shaken the horny hand of a miner! To those of us who have worked or travelled in those regions, "Hangtown," "Red Dog," "You Bet," "Hell Hollow," "Bloody Run," "Gouge-Eye," "Devil's Gate," "Ague Flat," and "Death's Canon," are time-honored and familiar names, but with the generality of mankind, how different! Of these, few could read of "Small Pox Creek," "Hell's Mouth," "Shirt Tail Canon," "Death's Ravine," or "Murderer's Gulch," without at least a slightly unpleasant feeling, yet such are the names which some of our hardy pioneers will hand down to posterity.

At the foot of Cunningham Gulch, in the small community of Howardsville, about five miles from Silverton, Colo., stands this old log cabin that was the Court House where the first patented claims of the San Juan district were recorded in 1870. Sights like this stir the imagination and make the mining industry appreciate the great progress it has made in the last 75 years. A glimpse into the future of mining for the Western Hemisphere will be portrayed in the August issue of *E.&M.J.*

Exide

The battery that helped to build America ...now helps to make her STRONG

THE same dependability in Exide Batteries that has made them so real a part of America's industrial progress now gives these batteries an even graver task.

In the nation's military forces—in the Army's mechanized divisions, in the air force, and in the Navy—Exides have been entrusted with functions in which no battery dares fail.

Behind these front lines of defense—in our mines and manufacturing plants, our farms, our railroad and communication systems, our fleets of buses and trucks, our electric generating plants, steamship lines, fishing fleets, and Diesel-powered construction equipment, even in our hospitals and public buildings—Exide Batteries are steadily, dependably serving the nation.

It is not by chance that Exides have been placed in so many key positions. For fifty-three years they have been proving how well they merit this confidence.

Most storage batteries look very much alike—outside. Inside, you find the differences that count. In an Exide-Ironclad you find a positive plate unlike all others. Slotted rubber tubes retain the active material while exposing it freely to the electrolyte. Higher power ability, greater ruggedness, and longer life are the result. This is but one example.

Look behind an Exide Battery and you find a manufacturer and a service organization with policies designed to benefit the user by insuring the utmost in performance, and the longest, most dependable and economical battery service that human skill can provide.

These are the reasons why you can confidently entrust your own battery needs to Exide.

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IRONCLAD
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

CALIFORNIA

Mill Being Planned for Little Castle Chrome Mine

Property in Shasta County has been explored by U. S. Bureau of Mines—No. 1 tungsten mine of Atolia Mining Co. reopened

▶ Increased operations are planned at the Little Castle chrome mine, near Dunsmuir, Shasta County, subleased recently to G. I. Dumond by Manley M. Brown, who has carried out development work for several years. The property has been under investigation for some time by the U. S. Bureau of Mines, with about 20 men employed in drilling operations and other exploratory work. Installation of a treatment plant is planned. Shipments of chrome ore were made during the World War, when the mine was operated by the California Chrome Co.

▶ No. 1 mine of Atolia Mining Co., Atolia, Kern County, was reopened recently, and a small crew of men is employed on exploratory work. The Amity shaft has been sunk 80 ft. to the 400 level, which will be followed by driving a drift to connect with the neighboring Union as soon as the new shaft station has been cut. Milling operations are on a continuous basis, the flotation section of the plant handling accumulated tungsten tailings and the concentration plant treating periodically underground ore. More than 50 men are employed under the direction of Hugh W. Coke, superintendent.

▶ Development work is in progress at the property of Magee Mercury, Inc., formerly known as the Great Northern quicksilver mine, in Sonoma County, with some 20 men employed. The company is headed by H. H. Magee, with B. C. Austin, consulting engineer of San Francisco, as vice president and engineer. Thomas A. Monahan, Guerneville, is manager and in charge of operations.

▶ Yuba Consolidated Gold Fields, Ltd., F. C. Van Deinse, vice president in charge of operations, is moving its 9-cu.ft. dredge from the Merced Falls area for remodeling and subsequent reinstallation on placer ground along the Tuolume River near Waterford, Stanislaus County.

▶ William Richter & Sons, dragline dredging operators of Oroville, have started operations on the Ponta Ranch, in Indian Valley near Downieville, Sierra County, following removal of equipment formerly at work on ground along the Middle Fork of the Yuba River near Freeman's Crossing bridge.

▶ Piedmont Dredging Co., headed by C. A. Palmer, San Francisco, is preparing placer ground on the McLean property, near Chico, Butte County, for early exploitation. Men are at work repairing roads, on a power line, and excavation of a dredge pond to accommodate the single-bucket Becker-Hopkins unit built by Yuba Manufacturing Co.

▶ One hydraulic monitor is at work at the Kreth mine, near Buena Vista, Amador County, owned by Henry Kreth. Material washed into a pit by the monitor is raised into the sluice by an hydraulic elevator, and water is obtained via the old Lancha Plana ditch, with a six-mile pipe cut-off serving the monitor.

▶ Mining operations have been resumed at the German Ridge and Jupiter mines near Angels Camp, Calaveras County, by Western States Gold Mines Corp., Clifford McClellan, manager. The mill available at the property has been reconditioned and is ready to treat some of the ore blocked out previously.

▶ Cuban-American Holdings, Ltd., 367 Mills Building, San Francisco, announce they have taken over the Bradi-Mason manganese property, in Plumas County, Calif., and have started production. E. L. Reeves is in charge of operations. Western Mineral Associates has contracted to purchase the first 12,000 tons of ore, said to run 45 per cent manganese. The company also plans exploitation of a mica deposit at Wells, Nev. James J. Kenney is secretary-treasurer of Cuban-American Holdings, Ltd.

▶ Underground operations at the property of Alabama California Gold Mining Co. near Penryn, Placer County, have reached a depth of 1,500 ft., with a new station being cut in the shaft at that point. The mill is handling around 250 tons of ore a day mined on the 650, 800, 1,000, and 1,200 levels. Additional drifting on the 650 and 800 levels is in progress. James Moore, superintendent, is in charge.

▶ Ancho-Erie Mining Co., headed by Grass Valley interests, has taken over the Ancho and Erie mines, near Granitville, Nevada County, which have been under development by Fred Anderson and C. A. Helbach for two years. Work is centered on extending the main tunnel 550 ft. to reach the Ancho vein. Additional development work is planned.

▶ Rehabilitation is in progress at the Celia quicksilver property 10 miles south of El Dorado, El Dorado County, acquired recently by Madre de Oro Gold Mines, Inc., operators of the Church mine, in the same area. The mine was first worked more than 80 years ago, and has remained inactive for a long time. A flotation mill with a maximum capacity of 350 tons has been completed by the company at the Church unit. W. J. Loring, managing engineer, is in charge.

▶ The Index mine, on Quimby Creek near Denny, Trinity County, is scheduled to be reopened soon. It was discovered in 1900, and operated until 1910 by the Index Mining Co. Construction of a road to the property is nearing completion, and installation of machinery preparatory to development work is planned by the new operators.

▶ About 3,000 yd. of gold-bearing gravel are being handled by the dredge of Etna Gold Dredging Co., controlled by Oakland interests, at Etna, Siskiyou County. O. Bahrenburg is dredge master, and 17 men are employed.

Government Seeks Mineral Economists

THE GOVERNMENT is looking for persons especially qualified in the economic aspects of the mineral industries to do professional research in the fields of minerals, coal, and petroleum. Civil-service examinations for these positions are now open. The salaries range from $2,600 to $5,600 a year. Further information, including the exact education, experience, and substitution provisions, is contained in the formal announcement. Announcement and application form may be obtained from any first- or second-class post office or from the Civil Service Commission, Washington, D. C.

NEVADA

More Magnesite From Mammoth District Planned

Output by Barium Products Company, Ltd., to be increased from 100 to 400 tons per day later in year—Another large roaster kiln installed at Getchell mine

▶ Magnesite, mined by power shovel, hand-sorted, crushed to 4-in. size, and trucked in bulk 32 miles to stockpiles at the Luning rail point, is being shipped at the rate of 100 tons per day from the Mammoth district, northwestern Nye County, by the Barium Products Co., Ltd., to its plant at Modesto, Calif., and to the Newark, Calif., plant of the Westvaco Chlorine Products Corp., near the south end of San Francisco bay. By Sept. 1 production will have been increased to 400 tons per day. Processing of magnesite at both plants is still on an experimental basis, it was stated, preliminary to a far larger output to be supplied the Los Altos plant of the Permanente Corp., headed by Henry J. Kaiser, to whom the Federal RFC has made a grant of $9,250,000 for construction of a $12,000,000 magnesium plant. R. O. Jones, in charge for several years of barite production in Lander County for the Barium Products Co., is manager with office at Luning.

▶ Installation of a second 7½x260-ft. rotary ore-roasting kiln is in progress near the cyanide mill of the Getchell Mine, Inc., in eastern Humboldt County. The kiln, fabricated by the Traylor Engineering & Manufacturing Co. at Allentown, Pa., has been delivered in sections and trucked 16 miles from the rail point at Redhouse. The kiln will be oil-fired for the greater part of its length, whereas the first kiln, of similar dimensions, is fired at the intake end. Addition of this kiln does not entail an increase in mill tonnage; as underground work is extended, the proportion of sulphide ore to surface oxidized ore increases. The former requiring a primary roast at around 1,200 deg. F to drive off arsenic and sulphur before cyanidation. Baghouse equipment has been provided to recover arsenic, heretofore going to waste. Fred Wise, Redhouse, Nev., is superintendent.

▶ Construction of a 200-ton cyanide mill is under way on gold property of the Marigold Mines, Inc., south of Valmy, a rail station in southeastern Humboldt County. Part of the equipment is being

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▶ NEVADA

taken from a 60-ton mill built by the company two years ago at Unionville. A substantial tonnage of shipping-grade ore has been produced in late months from the Valmy mine and shipped to the McGill smelter. Lou M. Louis, construction engineer of Reno, is building the new mill. Frank E. Horton, owner of the formerly productive Weepah mine, is president and manager at Valmy.

▶ Metallurgy of cobalt-bearing ore, reported present in large volume in old copper and lead-zinc mines of the Goodsprings district, Clark County, has been solved in laboratory and mill tests, it is claimed, following a run of 600 tons of 1 per cent ore in the 40-ton Shenandoah mill, equipped with a specially designed flotation unit. Steps are being taken to provide a larger plant for the recovery of cobalt. Herbert Woodward, metallurgist of Goodsprings, and A. E. Place, managing engineer for the Wall Street mine, at Eldorado Canyon, are conducting further tests on the cobalt ore and working together on processes to produce zinc oxide from the zinc carbonate of the Sultan and other mines, present at many points and for which the ore has been penalized heretofore at smelters. Attention also is being directed to deposits of vanadium and scheelite at Goodsprings, where metals of greater variety are found than in any other Nevada district, the list including gold, silver, lead, zinc, copper, platinum, palladium, vanadium and cobalt, together with barite, gypsum, mercury, and radium, according to United States reports.

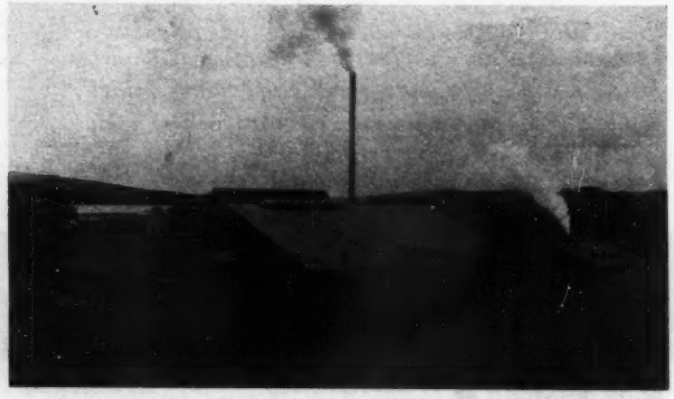
▶ Cinnabar properties in the Goldbanks district, Pershing County, have been acquired under option by the Bradley Mining Co., headed by Worthen Bradley, Crocker Building, San Francisco. For several years Melvin McCoy, leasing the Goldbanks mine, has operated a retort furnace of his own design, producing 25 lb. of mercury per day. O. L. Cash, manager of productive Cinnabar mines for the Bradley group near McDermitt, is in charge at Goldbanks, with an office at Winnemucca.

▶ Diamond drilling, conducted from the 900-ft. level of the 1,200-ft. Locan shaft of the Richmond-Eureka Mining Co., on Ruby Hill, two miles west of Eureka, has been discontinued with late completion of the third drill hole to the quartzite at 1,560 ft. Drilling has been done under contract by the E. J. Longyear Co. for the Eureka Corporation, Ltd., composed of a small Canadian group headed by Thayer Lindsley, of Toronto, holding a long-term lease on the formerly productive lead-silver properties. The Eureka Corp. also operates the Oswego gold mine, in Secret Canyon, 6 miles south, from which in the past year and a half it has trucked upwards of 2,000 tons of ore to the McGill Kennecott smelter. The suspension of drilling, said to be temporary, was ascribed to war restrictions in Canada. William Sharp is directing engineer at Eureka.

▶ Recent installation in the cyanide mill of the Northumberland Mining Co., in northern Nye County, of a 5x7-ft. Allis-Chalmers ball mill and larger motors, was said to have enabled an increase in mill feed to 350 tons per day or nearly double the tonnage to which grinding equipment had been limited by the nature of the ore, a blocky, unlaminated, and tough schist that is mined by power shovel. Walter Haggerty, of Beverly Hills, is president and J. C. Perkins, manager, has an office at Tonopah.

View of open-pit gold mine of the Getchell Mine, Inc., near Redhouse, Nev. Ore is hauled to the company roasting plant and followed by treatment in the 1,000-ton cyanide plant

▶ The Ely Gold & Manganese Co. has been operating the Cuba mine adjacent to the town of Ely, Nev., since Dec. 10 of last year and has carried on a comprehensive development program. It is reported that the company is producing about five cars daily and shipping to the McGill smelter, the silica content being very high. Ogden C. Chase is president of the company.



View of roasting plant and 1,000-ton cyanide plant at the Getchell mine, near Redhouse, Nev., where a new Traylor 250-ft. roasting kiln and an arsenic-recovery unit are being installed

ARIZONA

Trucks and Trailers To Increase Ore Haulage

The Gold Standard, Inc., prepares to increase its stockpile of ore—Small mill to be erected at Polaris mine near Clifton

▶ The Gold Standard, Inc., operating the Tyro mines, is arranging a new haulage plan by trucks and trailers in conjunction with the highway department of Mohave County which has been relocating and improving the road between the mine and the mill. Trucks and trailers with capacities of 25 tons per cargo will replace the small 5-ton trucks that have heretofore been used in the hauling ore 6 miles from the mine to the mill. The mill is treating about 250 tons of ore daily. Richard de Smet, Kingman, Ariz., is managing director.

▶ A mill is being erected on the properties of the Polaris Mining Co. 10 miles north of Clifton. Shipments of ore have previously been made from the property and a substantial quantity of ore is reported broken at the mines. J. W. Buckley of Clifton, Arizona, is president of the company.

▶ C. P. Dennis and associates, of Parker, owners of the Golden Ray mine, 10 miles north of Parker, have leased the property. Shipments of ore already made show values in gold around $50 per ton. A. Z. McClure is directing the operations and a crew of six men is now employed.

▶ Production has been started at the Gloryany gold mine, 4 miles south of Bumble Bee. The mill has been put in

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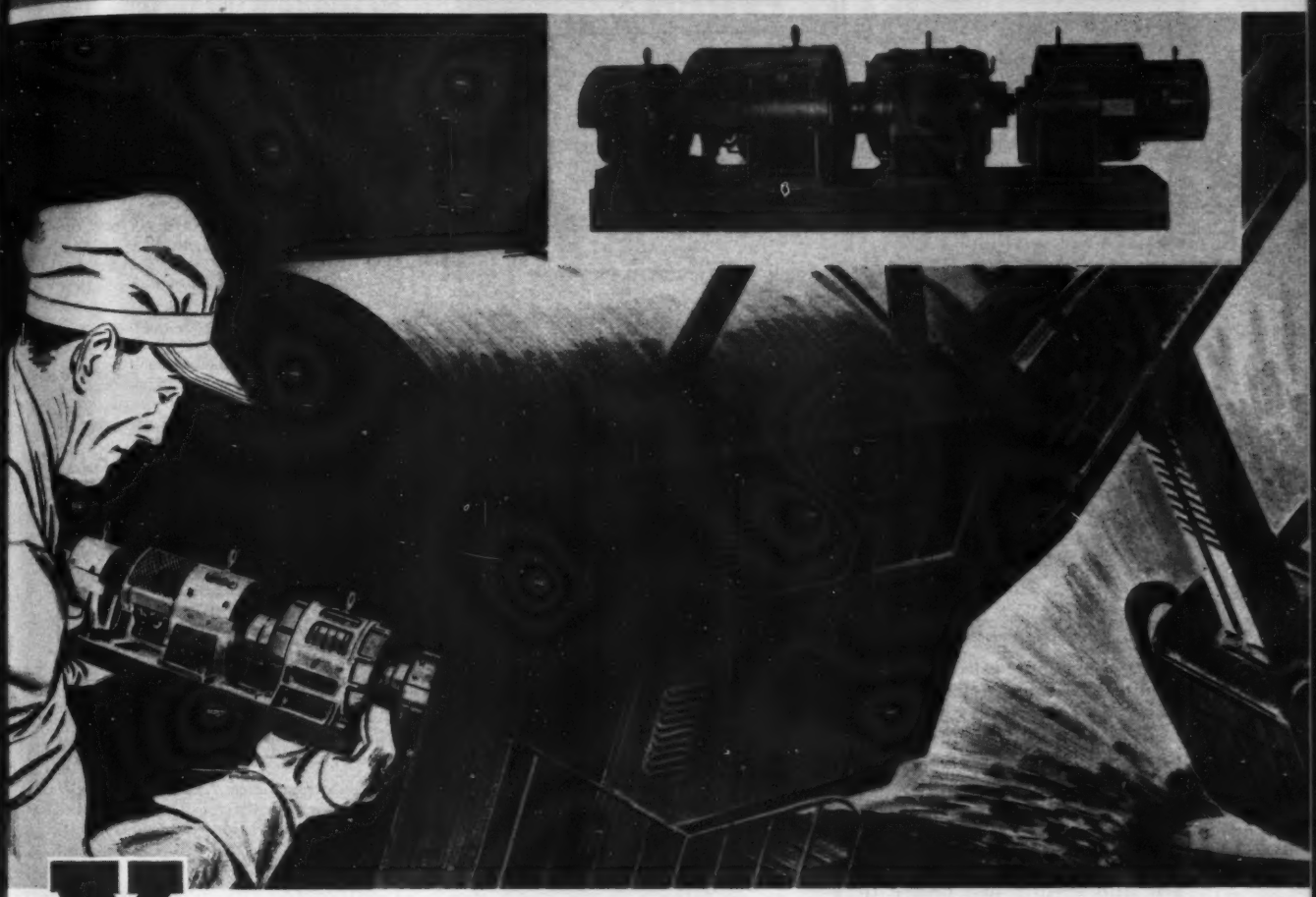

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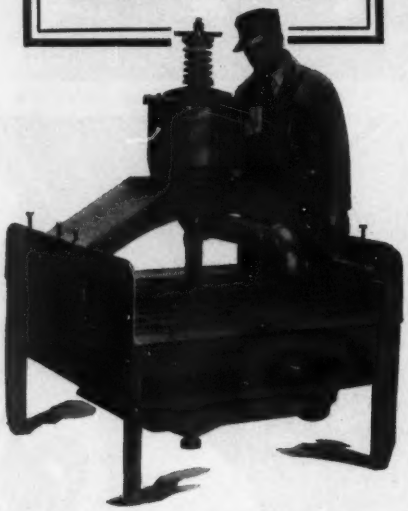

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▶ARIZONA

good condition. E. A. Bravender, of Rock Springs, is leasing the mine and has a small crew working.

▶ A copper property situated near Jacobs Lake, three miles north of the Grand Canyon, is being developed by Charles A. Palmer, of Las Vegas, Nevada. Mining will be done by steam shovels.

▶ Horace Armishaw, of Chloride, is developing the old Tintic mine, owned by Harold Hawks, of the same place.

▶ The Emerald Isle Copper Co., holding properties in the Cerbat Range, near Chloride, Mohave County, recently completed its 300-ton leaching plant.

▶ The Davenport Mining & Reduction Co. has acquired the Oro Plata holdings, purchasing the mining properties and the 140-ton flotation plant. During the past several months this mill has been converted into selective flotation in order to produce a zinc concentrate from the zinc ores in this area. Mr. Chase, president, has announced the purchase of the Idaho and Broken Hills properties and contemplates the early acquisition of two other large properties in this group.

▶ C. O. Hewin and associates, operating the Tin Cup mine in the Secret Pass area of the River range 20 miles west of Kingman in Mohave County, are shipping about 50 tons daily of good-grade gold ore to the milling plant of the Producers, Inc., 6 miles west from Chloride.

▶ Tungsten Reef mine, under lease to J. J. Seeman, at Hereford, is producing 20 tons of scheelite daily. The mill is handling 2½ tons an hour, crushing, jigging, and concentrating. The property is owned by the Tungsten Reef Mines Co., 4306 Budlong Ave., Los Angeles, Calif.

UTAH

Elton Tunnel Nears Rood Shaft

Connection expected to be made this month—Water in Utah Apex mine drained through diamond drill holes—Development resumed at North Lily mine

▶ Completion of a four-year tunnel-driving project appeared to be but a month off when employees of the National Tunnel & Mines Co. resumed work in the 4½-mile Elton tunnel near Tooele, advanced at a cost of $1,250,000 to furnish drainage and low-cost transportation for Bingham properties. Drainage of the Rood shaft of the Utah Apex mine had been practically completed by diamond-drill holes, which were carrying off water at the rate of 5,300 g.p.m. Only 565 ft. of formation remained between the face of the tunnel and the 2,475 level of the Rood shaft. Previously, the adit had been advanced at an average rate of 25 ft. daily. If this pace can be maintained, officials estimated that the connection should be made around the middle of July.

▶ Kennecott Copper Co. may have $196,014 added to its 1941 tax bill on Utah Copper properties as the result of a legal opinion signed recently by Attorney General Grover A. Giles. Kennecott Copper had claimed that it was entitled to a $4,700,595.66 deduction from its 1940 net annual proceeds, as this amount represented the value of the purchase price of the Bingham & Garfield Railroad. The opinion, requested by the State Tax Commission, held that the two companies should be regarded as one corporation, and that the purchase transaction was merely a matter of bookkeeping, not one justifying a deduction for taxation purposes.

▶ Officials of the International Smelting & Refining Co. have given orders for a resumption of development work at the North Lily mine, in the Tintic district. The main North Lily shaft is being sunk from the 1,400 to the 1,800 level to prospect the Eureka Lily fault, the "second line dike," and a series of parallel fissures. Work is being done under the direction of J. F. Dugan, general superintendent. Exploration will also be carried on in the Tintic Bullion area.

▶ The Prosper Mining Co. is operating its 30-ton mill near Milford three shifts daily on tungsten ore from the Old Hickory.

▶ A 20-ton concentrating plant for the treatment of tungsten ore has been completed on Trout Creek, south of Callao, in west Juab County. Development has been carried on by the Babick Brothers for nearly six years.

▶ Exploration on two Dry Canyon mining properties at Ophir—the Treasure Hill and the Western King—are nearing important objectives. The Treasure Hill incline shaft is below the 150 level of the Madison Mines in leased ground. The company plans to do about 4,000 ft. of diamond drilling. The Western King Mines incline is now down over 570 ft. to explore fissures in the Madison limestone in ground leased from the Ophir Queen Mines. Kearsarge, Inc., has been organized to develop the old Mono and Kearsarge properties, in the Ophir Mining district. Alonzo Mackay (Atlas Building, Salt Lake City) is president and manager. A drift is being advanced east from the Mono tunnel at a point 500 ft. from the portal.

▶ Diamond drilling has been started in the Tom Moore Tunnel, at Alta, under the direction of J. J. Beeson, to find the faulted segment of the old Emma orebody, which in lower horizons produced heavily. The tunnel has been cleaned out to a point 2,000 ft. from the portal, making 5,000 ft. of workings accessible. Operations are being financed by the Howell Mining Co.

▶ The New Park Mining Co. has approximately a year's ore reserves opened up above the Mayflower Tunnel near Keetley, in the East Park City district, W. H. H. Crammer, general manager, reported recently to stockholders. A three-compartment shaft is being equipped to reach to the 1,500-ft. level to explore the Park Bingham fissure. A crosscut is being driven to explore the Rosebud fissure. The company has also opened up the Gold Queen tunnel for 1,125 ft. and a crosscut extended 100 ft.

MONTANA

Nodulizing Plant Starts Production

New unit of Anaconda Copper Mining Co. gets under way to produce between 250 and 300 tons of high-grade nodulized manganese per day

▶ The new manganese nodulizing plant of Anaconda Copper Mining Co. at Anaconda started operations on June 21. Ore comes from the company mine at Butte and is transported to Anaconda, 27 miles away. Under normal operating conditions the plant will produce from a daily average of 1,000 tons of manganese ore between 250 and 300 tons of high-grade nodulized ore per day. D. M. Kelly is vice president and general manager of operations at Butte, Mont.

▶ Cornelius F. Kelley, chairman of the board of Anaconda Copper Mining Co., recently announced that the board of directors of the company has authorized the calling for redemption on Aug. 11, 1941, of $2,100,000 principal amount of 4½% sinking-fund debentures of the company (out of a total of $4,025,000 principal amount outstanding) at the redemption price of 101, plus accrued interest. Notice of the numbers of the debentures called for redemption will be given as soon as the same have been drawn by lot by the trustee.

WASHINGTON

Option Renewed on Magnesite Property

Westvaco Chlorine Products Company interested in property pending outcome of research on recovering metallic magnesium from magnesite ore

▶ S. A. Kulzer, director of the Double Eagle Mining Co., reports that the option the company granted to the Westvaco Chlorine Products Co. on its magnesite properties 12 miles west of Valley, Stevens County, expired June 1 but has been renewed for six months. The renewal was asked because the U. S. Bureau of Mines has not yet completed at Pullman, Wash., the electro-thermic reduction method of recovering metallic magnesium from the magnesite ore in Stevens County.

▶ Sixty mining engineers, members of Columbia and North Pacific sections of American Institute of Mining Engineers, inspected the Holden mine of Howe Sound Co., on June 8. This property is in the Cascade Mountains, above Lake Chelan. The present payroll numbers 480, with more than 100 individual homes. Visitors were informed the enterprise has a life expectancy of 20 years, with a possibility of additional ores being developed. The rate of output is 5 tons of ore per day per man. John J. Curzon, manager of the property, and several assistants, showed the visitors

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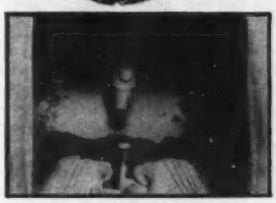

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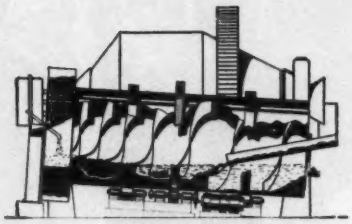

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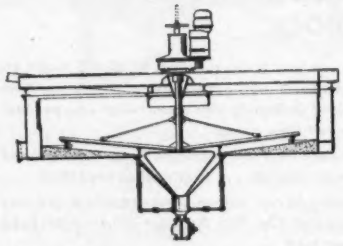

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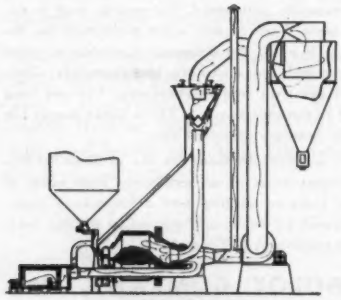

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▶WASHINGTON

through the mine, the mill, and the camp where 1,000 persons now live. The mill treats about 2,500 tons of copper-gold ore each day, recovering 30 lb. of copper and about $1.75 in gold and silver per ton. Among staff members under John J. Curzon are J. K. Brook, general superintendent; H. A. Pearse, mill superintendent; E. B. Douglas, chief engineer; F. A. Taft, mine engineer; N. D. Lindsley, efficiency engineer; H. B. Smith, geologist, and Harry Clemmer, master mechanic.

▶In the June issue of *E.&M.J.*, page 76, readers may have placed the inference that the complete earnings of Howe Sound Company for the first quarter of this year were derived from its Holden mine, in the State of Washington. The earnings figure printed was $800,480. This was a typographical error; the correct earnings figure should be $300,480 for the company's mining enterprises in Canada, Mexico, and the United States, compared to $558,278 in the same quarter last year.

▶Sunshine Mining Co., is reported to be starting work on the development of a manganese property which the company acquired several months ago in the Fairholme district of the Olympic Peninsula and near Mount Mueller at the west end of Crescent Lake, near Port Angeles, Wash. Rowland King, of Spokane, resident engineer for Sunshine, will direct development operations with Sunshine's general manager, R. D. Leisk. Sunshine is said to have a contract with the government for the sale of the manganese product if tonnage can be developed.

▶Chinto Mining Co. is about to start work on its third level at its property 5 miles northeast of Chewelah, Stevens County. The company first sank a 200-ft. shaft, opened the first level with a 900-ft. drift then opened the second level at 200 ft., with a 1,100-ft. drift. From these two levels 3,300 tons of ore has been treated in its 25-ton pilot mill. It averaged $12.50 to the ton in silver, copper, and gold. When the third and fourth levels are developed the company intends to increase the mill to 60 tons. E. M. Spedden is superintendent.

OREGON

Washing Plant Begins Gold Recovery on Forest Creek

Dragline dredge unit is moved from Big Applegate River—Other small placer operations under way

▶Southern Oregon Mining Co. has moved its dragline and floating washing plant from the Hamilton-Taylor place, on Big Applegate River, to Forest Creek. The company is beginning operations near the Hayfork Exploration Co.'s ground and will work down stream to the mouth of Forest Creek.

▶Harry Walker and LaBonne Colvig have been working the Jacks Creek placer, on Jacks Creek, a tributary of Jump-off-Joe Creek. They pipe the water from Jacks Creek and use two hydraulic giants. The operation is in the Grants Pass area.

▶Russell Mitchell and D. A. Wright, of Jacksonville, report tungsten deposits on their Mock Gulch claims, west of Brush Creek, a tributary of Carberry Creek. A small shear zone, 3 ft. wide, has been opened, exposing a vein showing scheelite. Exploration will continue.

▶Jackson Mining Co. has installed a dry-land washer and dragline east of Jacksonville. The plant was designed by E. B. Skeels, of Auburn, Calif.

▶H. F. England & Co., which has been operating on Dixie Creek, near Prairie City, for two years, has moved its equipment to a location at Idol City, 28 miles northeast of Burns, where it estimates it will have another two-year operation.

▶F. L. Wilson and Ralph Hatley, of Sumpter, have installed a dragline dredging operation on Powder River, near the old Evergreen ski course. They put in the equipment during the winter and spring. A half-yard dragline shovel is used.

ALASKA

Ground on Sweepstakes Creek Being Tested

Placer season started early in several districts this year—Large dredge of United States Smelting, Refining & Mining Co. being assembled at Nome

▶Placer operations are well under way on Seward Peninsula, where it was possible to bring in supplies and equipment early in the season. Carl Hallberg has brought a placer drill from Nome to Haycock to test the ground on Sweepstakes Creek. Al Goodwin is drill master.

▶The steamship "Derblay," for its first voyage of the season, carried 2,500 tons of equipment, most of which consisted of a dredge for the operations at Nome and Fairbanks of the United States Smelting, Refining & Mining Co. It was expected it would require seven weeks to assemble the dredge parts after they arrived at Nome. This shipment got away at an early date this spring, with the hope that the company will be able to get into operation this year.

▶A diesel-powered gold dredge is being built on the Moffat Flats placer ground under lease to A. Himmelman. A California company is said to be installing a modern dragline floating dredge, which will be operated by Mr. Himmelman.

▶About sixty thousand dollars' worth of tungsten concentrate is planned to be shipped monthly through Prince Rupert from the 100-ton mill near the Riverside mine, on Salmon River. J. H. Scott, of Riverside, Calif., is managing director.

▶Operations are being resumed at the Denali Mines, Inc., property on upper Nugget Creek, in the Cache Creek district. Fred D. Hougham is president and in charge of the work. Jack M. Adams is engineer and superintendent.

IDAHO

Polaris Mining to Drive Long Crosscut

Objective is to explore the Chester mine and property of Mineral Mountain Mining Co. from the 2,300-ft. horizon of the Polaris shaft—Hecla company pleased with development of wide vein on 800 level

▶Contract agreements have been signed between the Polaris and Chester mining companies and the Mineral Mountain Mining Co. whereby the Polaris will drive a deep crosscut into Mineral Mountain ground from the 2,300 Polaris shaft level. The work will prospect a large section of virgin ground in the silver belt. It will develop all of the hitherto unexplored ground in the Chester property, control of which is held by Polaris, and will also prospect the Eleventh Hour group, recently acquired by the Polaris, in addition to opening the Mineral Mountain vein at a depth of 1,600 ft. from the surface. The development work will be directed by R. S. Merriam, engineer for the Mineral Mountain.

▶The Hecla company is drifting east on the north wall of the lead-silver vein recently opened on the 800 level of the Atlas shaft, at Mullan. The drift measures 6x8 ft. in cross-section. All work has been in a milling grade of lead-silver ore the full width of the drift, and the management is well pleased with the development.

▶Virginia Mining Co., owning property in the Beaver district, has sold an undivided two-ninths interest in the Virginia lode mining claim to the Monitor Mining Co. for a consideration of 28,000 shares of Monitor stock, valued at $14,000.

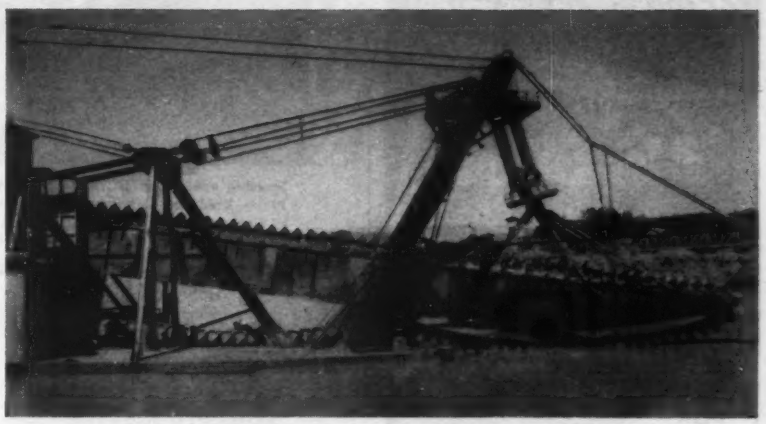
▶The Triumph Mining Co., operating at Hailey, in Blaine County, is producing at the rate of 350 tons of lead-silver ore daily, according to E. H. Snyder, general manager. The ore also contains gold and zinc. The company is installing a new flotation plant.

▶The Sunshine mine was closed for several days during June by an accident caused by an air blast in which two miners lost their lives. Cause of the blast is unknown, but engineers are of the opinion it was due to a combination of causes that resulted from pressure and fault movements.

▶Bradley Mining Co.'s property at Stibnite, in the Yellow Pine district of central Idaho, is reported to now be the largest producer of antimony in the United States. The property is also said to be the second largest gold producer in Idaho.

▶The Ima Tungsten mine, at Patterson, is reported to be producing 100 tons of mill ore per day, with 70 men employed. The company is now installing a new 600-cu.ft. air compressor, with which it is expected to double the mine production. The company owns the largest producing tungsten mine in Idaho.

DEEP DIGGING PLACER DREDGES



Digging Ladder Yuba Consolidated Gold Fields No. 20.

Placer dredges for deep digging are operating successfully in California today largely due to the use of Patented Perry Bucket Idlers. Yubas No. 17 and No. 20, near Hammonton, California, using these idlers, are digging 112 ft. and 124 ft. below water level respectively—and are digging against banks 50 ft. or more high where necessary.

Providing better control of the bucket line catenary, the Perry Bucket Idler is mounted about midway on the underside of the digging ladder. The buckets ride on the lips over the idler which is contoured to suit. Practically no wear is noticed in the idler itself—and the lives of bucket bushings, pins and tumbler wearing plates are lengthened materially, reducing operating costs.

Here is another example of Yuba's constant touch with dredging operations 'round the world. New developments, field tested, affecting equipment and operating practices are investigated by Yuba and, if worthwhile, are made available to operators. You perhaps can eliminate costly experiments in your dredging by checking with Yuba. Changing conditions can be analyzed and suggestions made to keep your equipment up to the operating efficiency for which it was designed.

Yuba exclusively, through arrangement with the patentee, offers the industry, either directly to operators or through manufacturers, the right to use Patented Perry Bucket Idlers on deep digging placer dredges. Write for further information and quotations. There is no obligation, of course!

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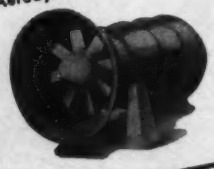

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FOR USE IN ANY SEAM

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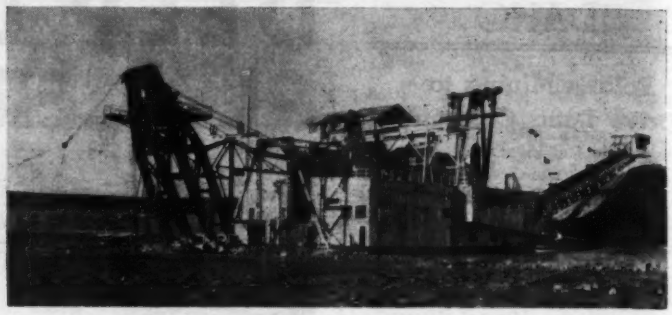

Starting operations on June 11 this year, this new gold dredge of the South Platte Dredging Company will exploit a large placer area two miles south of Fairplay, Colo. Buckets are of 11 cu. ft. capacity and Bendalari jigs are employed in gold recovery followed by riffles

COLORADO

Zinc Production Started at Gilman

Mine of New Jersey Zinc Co. begins operations treating ore in underground mill—Vanadium plant at Rifle being rehabilitated—New large dredge begins operations at Fairplay

▶The New Jersey Zinc Co. recently started exploiting its zinc orebody at Gilman. Mill operation started around June 15 with the underground plant treating between 500 and 600 tons of ore per day.

▶The U. S. Vanadium Corp. has started rebuilding the old vanadium plant at Rifle, Colo. The Rifle plant construction is necessary to meet defense demands for vanadium, and according to J. R. Munro, Manager of U. S. Vanadium in Western Colorado, rehabilitation will be completed as quickly as possible.

▶The new dredge of the South Platte Dredging Co. started excavating June 11. The dredge is in operation south of the city of Fairplay. Mr. Dinkelman is dredge superintendent.

▶An 8-cu.yd. dragline shovel and Bodinson dredge is being assembled at Alma, Colo., for the Timberline Dredging Co. This equipment will be installed to exploit a placer area between Alma and Fairplay. J. R. Henderson, Fairplay, is superinetndent, and D. Killin, of the Denver office is purchasing agent.

▶Climax Molybdenum Co., operating Climax, has been increasing output and changes are now being made in the regrind plant of the mill to insure increased production. Preparations are under way in the mine to exceed 15,000 tons daily, within the next thirty days' eventually reaching between 17,000 and 18,000 tons of ore daily. J. C. Abrams is general superintendent, F. S. McNicholas ass't general superintendent, James Sweet mine superintendent, and E. J. Duggan mill superintendent.

▶Under the supervision of George Rowe, the Mile High Mining Co., composed principally of Denver men, has completed unwatering the Terrible mine, at Georgetown, and ore has been opened in the fifth level which shows assay values from 200 to 500 oz. silver per ton.

▶The Mytus Gold Corp., operating the Colorado City Trail mine, reports having shipped 17 carloads of ore during April, which averaged $12.47 per ton; and that the mine became substantially self supporting from then on. K. M. Ohlander is president of the corporation.

▶During the latter part of April the Ingram lease, at Boulder, bought a new 18-ton Chevrolet tractor and trailer unit, to haul ore to the smelter. An analysis of the use of this tractor trailer shows the following: Cost per mile for the first 10,000 miles—gas, oil, driver, repairs, and wheel tax, totaled $0.0753; as a round trip averages 230 miles, the tractor trailer averages about 5,000 miles per month and costs approximately $17.32 per round trip, or $0.977 per ton, which together with depreciation and switching charges at the Golden Cycle Mill is considerably less than the railroad transportation for hauling ore. The use of tractor trailer outfits in mountainous country offers greatly to facilitate the movement of ores and concentrates.

▶The Carleton tunnel near Cripple Creek, Colo., is expected to revive mining operations in the Cripple Creek district before the end of the year. Superintendent John R. Austin and his staff have completed nearly 32,000 ft. of the drainage tunnel, and the driving toward the Portland shaft is moving along steadily. The heading toward the Ajax shaft is more than half completed and the lower levels of the Ajax shaft have been completely drained, permitting extensive new development work and also work on the deep veins which were uncovered nearly two years ago. Merrill Shoup, president of the Golden Cycle Corp., states it is impossible at this time to make an estimate on the probable increase of gold output from the district mines on completion of the tunnel.

▶Approximately $50,000 will be spent soon on the Mt. Champion mining property, 45 miles north of Buena Vista, Colo., according to Elmer Paustion. The property has been worked all winter and

a good body of free-gold milling ore is easily available. A 50-ton mill is to be erected at the property.

▶The Cobalt Gold Mining Co.'s smelter, 4 miles north of Boulder, has made shipments totaling 150 tons of matte containing cobalt, nickel, gold, and copper. Ward Yager is general manager, with office at 1406 Pearl St. Boulder, Colo.

▶The Eureka Mines Co., operating the Eureka Tungsten mine under lease from the Gold, Silver & Tungsten, Inc., has reported the opening of the downward extension of an old tungsten orebody. Benny Newman, of Boulder, Colo., has been superintendent under the direction of Karl Egle and R. E. Anderson, owners.

▶The first unit of a new mill to handle tungsten-bearing ores in the Silverton district is well on its way to completion. The mill is housed in the annex of the Silverton Northern's shops near the Rio Grande Railroad station. Several small tungsten deposits are being developed and exploited.

▶The Baker Machinery Co., has installed new machinery in the old Spray & Gilbert property, at Nederland, Colo. The Golden Reward Mines Co., and A. J. Kraisinger president, has taken a lease on the property and on completion of minor repairs and the installation of this machinery will resume development work. The mill is expected to be ready for operation early in July. Mine and mill operations are under the supervision of Jack Glover.

▶Hecla Mining Co., Newmont, and the United States Smelting, Refining & Mining Co. have joined forces in the development and equipment of the Resurrection Mining Co.'s property in the Leadville district of Colorado. The mill is being constructed and expected to go into operation this summer.

TRI-STATE

Activity Continues Among Zinc Producers

Concentrate production gradually increasing as two new mills are completed—Several old mines reopened

▶With the advent of summer in the Tri-State district, activities feature several mine-dewatering projects, the completion of two new mills in the Missouri section, start of mine operations at three major shaft developments and the reopening of several old properties—all of which may result in blende production climbing to the 1937 peak level in recent years of around 10,000 dry tons, providing of course there is no corresponding falling off at present producing properties.

▶Just prior to the completion of the Short Creek drainage ditch, Fred Childress & Sons installed two large turbine pumps to dewater the old Galena, Kan., mining area. One pump was installed at the Murphy shaft in the creek bottoms and the other on the Southside

They Start ANYTIME *without unloading*

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It is never necessary to grind out the circuit before any shutdown

Whether a shutdown is planned or forced, it costs time and money. If you have AKINS Classifiers it costs you far less, because you need not grind out the circuit before you pull the switch, and you do not have to unload the machines before you start. The AKINS establishes normal circulating sand load and normal density overflow immediately.

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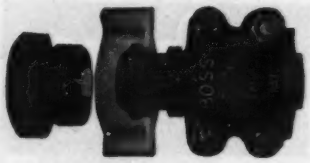
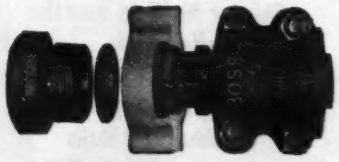
Dependable Hose Service Begins With "BOSS" Couplings!



"GJ-BOSS"
GROUND JOINT
FEMALE HOSE COUPLING
STYLE X-34

A washerless, leakproof coupling, correctly designed to insure unequalled efficiency and safety, plus protection for hose ends, on steam, air or liquid lines. Ground joint construction insures positive seal that *will not leak*, regardless of wear or the presence of abrasive particles. Sizes ½" to 4", inclusive, with 4-bolt "BOSS" Offset Interlocking Clamp on 1" and larger; 2-bolt "BOSS" Interlocking Clamp on ⅜" and smaller. Cadmium plated — rustproof. Malleable Iron "COR-O-ZIG" Stems on sizes 1¼" and larger; corrugated steel stems on sizes 1" and smaller.



"BOSS"
WASHER TYPE
FEMALE HOSE COUPLING
STYLE W-16

Same as above, except that head of stem and coupling end of spud are flat, to accommodate washer. Sizes ¼" to 4" inclusive, with same clamps and stems as "GJ-BOSS".

"BOSS" MALE COUPLING, STYLE MX-16

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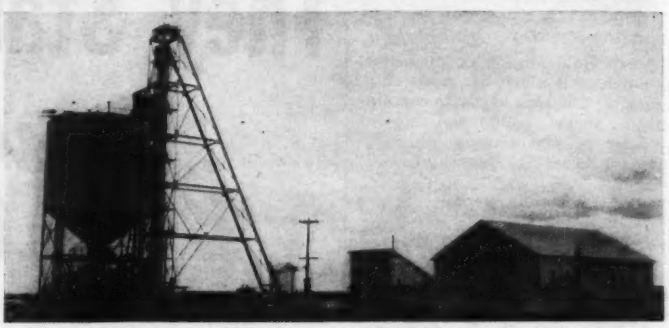


On the Blue Goose No. 2 lease, shown above, the Eagle-Picher Mining & Smelting Co. recently started operations, producing about 500 tons of ore each day that is hoisted in 2¼ ton skips that empty into the 600-ton hopper

▶TRI-STATE

mining tract. Despite heavy rains, the water was lowered several feet during the first three weeks of pumping operations. The pumps were subsequently speeded up to handle approximately 4,000 g.p.m. and the water was being lowered at the rate of 10 in. daily. With the dewatering of the old mines, which will require another 30 or 60 days, a revival of mining activities in the old field is expected to get under way.

▶ Preparatory to the reopening of the Granby mines and mill of the Federal M. & S. Co., which have been idle since 1927, the company has installed three turbine-type pumps to dewater the old mining area. The Granby-American mill is being reconditioned as a custom plant and will treat ore from five shafts—Mascot, Klondike No. 4, Argo, Crabapple, and Section 19. Granby holdings of the company comprise 7,500 acres in fee and 200 additional acres under lease, the latter including the Davis mine.

▶ At Oronogo the Eagle-Picher M. & S. Co. was preparing the latter part of June to install another 16-in. turbine pump at the Skinner shaft in the Oronogo bottoms to speed up the dewatering of mines flooded there during April.

▶ Two new mills in the Missouri section expected to get in production the latter part of June or the first of July were those of the Kansas Explorations, Inc., on the new Snapp land development northwest of Oronogo and the Harris Mining Co.'s rebuilt plant northeast of Aurora.

▶ Mine operations are now being carried on by the Eagle-Picher company at the two new shafts put down on the old Commerce Gordon lease, southwest of Treece, in Oklahoma, and the Blue Goose No. 2 shaft near Cardin. Ore rock from the three new mines is hauled by rail to the company's Central mill.

▶ H. D. Youngman, of Baxter Springs, has dismantled his tailing plant, north of Picher, in Kansas, and is rebuilding it on the Robinson lease, northwest of Treece, to handle mine ore from that lease.

▶ Among the old shafts being reopened throughout the district are the following: Shaft put down several years ago by the Kansas Explorations, Inc., on the Effie Hurlbut land, northwest of the St. Louis S. & R. Co.'s No. 9 mill near Waco, by General Mines, Inc., in which J. C. Barton, consulting mining engineer, and Paul Bradley, Joplin attorney, are associated. Dewey Simms, of Baxter Springs, and associates have dewatered the east forty workings of the old Hunt lease on the Joseph J. Whitebird allotment, a mile northeast of Picher, and will start mine operations soon. Skelton Lead & Zinc Co. is expanding mine operations on the Mary Calf allotment near Century, having moved derricks and hoppers to the Nos. 23 and 27 shafts, and is preparing to reopen the old Crawdad shaft north of the company's mill. Cameron & Henderson, Inc., have repaired the old No. 1 shaft on the Admiralty No. 1 lease, west of Douthat, from which an upper level of ore will be mined.

▶ Luther Eakens, of Carterville, and associates have completed and placed in operation a small tailings retreatment plant on the southeast side of the old Avondale tailing pile on the Aylor land, a mile west of Prosperity.

▶ Mary G. Mining Co. has taken over the operation of the old Dividend mines and mill at Spurgeon, according to John Gregory, of Joplin, who is in charge of operations. Mine operations are being carried on east and west of the old workings on the 87-foot level.

IRON COUNTRY

Cuff Mine, in Menominee Range, Being Tested

Property is under option by Globe Iron Co.—National Safety Council has meeting in Duluth

▶ A meeting of the Lake Superior mining section of the National Safety Council was held in Hotel Duluth at Duluth June 26 and 27. Mining men from Michigan, Wisconsin, and Minnesota representing thousands of miners in these states convened to discuss safety practises in the various phases of iron ore mining.

Menominee Range

▶ Near the city of Iron Mountain tests pits are being sunk to appraise the area around the old Cuff mine, by engineers of the Globe Iron Co., of Jackson, Ohio, which has an option on the property. William Doell is superintendent in charge of this work as well as the company's Cornell open-pit mine near the Cuff property.

▶ The State Conservation Department's geologic division has started mapping and making geophysical surveys of iron deposits in the western upper area of Dickenson County. The party is under the direction of Dr. Carl A. Lamey, of Ohio State University, and Dr. Carl E. Dutton, of Wayne University. Another party under the direction of Kiril Spiroff and the Michigan School of Mining and Technology and Dr. Justin Zinn, of Michigan State College, is conducting a survey of copper-bearing lodes in Ontonagon County.

Marquett Range

▶ A contract has been awarded to A. H. Prosch, Iron River, Mich., for the erection of five buildings, a tunnel connecting them, and a sewage-disposal plant at the new Sherwood mine, being developed by the Inland Steel Co. R. D. Satterly, superintendent of the company, said about five months will be required to complete the work. The program will cost approximately $150,000.

MEXICO

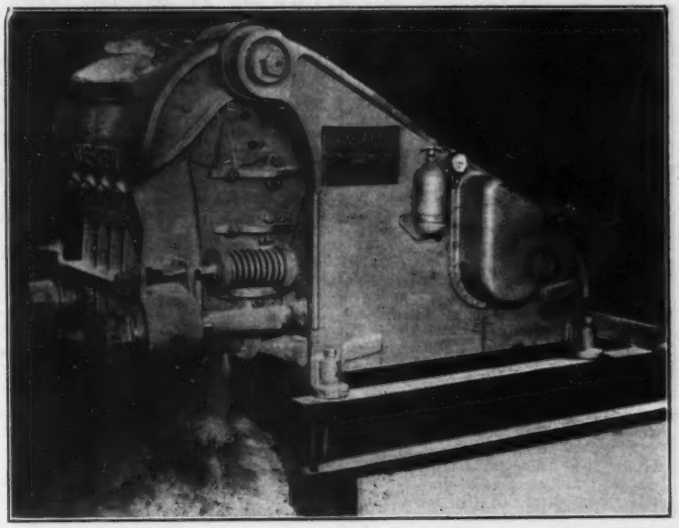
Iron Deposits in Guerrero Being Exploited

Mexican subsidiary of Bethlehem Steel Co. is operating property—Strikes averted at several mining units of A.S.&R.—Monterrey lead smelter strike settled

▶ Summer found the Mexican mining industry continuing to hope and mark time. American Smelting & Refining Co. averted strikes at its Santa Barbara, Chihuahua, and Angangueo, Michoacan, units by allowing the workers pretty much what they demanded, concessions that increase the firm's annual overhead by nearly 250,000 pesos ($52,000). Labor is still much to the fore in Mexican mining. Speakers, including Augustin Guzman V, secretary of the national miners union, bitterly attacked capital at the celebration in Mexico City the union staged on the 35th anniversary of the start of the strike in 1906 against Cananea Consolidated Copper, Cananea, Sonora. Capital, these orators declared, is today doing its utmost to rob the workers of their conquests by political means.

▶ Early and extensive working of a magnetic iron deposit, estimated to be of more than 100,000 metric tons, at Piedra Iman, near Xaltianguis, Guerrero, about 30 miles from Acaulco, important Pacific Coast port, and but two miles from the highway between Mexico

You Profit Two Ways with a Kue-Ken Crusher on the job



Cut milling costs . . . . Increase Mill capacity!

At a mine in Peru, Mill capacity was jumped 33% . . . another mine on the Mother Lode doubled mill capacity (names of mine owners sent on request). These facts prove that you can mill more ore with a Kue-Ken Crusher on the job.

Kue-Ken crushes hardest ores at a single pass . . . provides a finer mill feed . . . makes the grinding job easier . . . increases recoveries. The mine owner in Peru states . . . "the Kue-Ken Crusher paid for itself, transportation and installation in the first three weeks of operation". Costs of operation are extremely low . . . example: with jaws set at ⅝ to ¾ this Kue-Ken #20 requires only 10 H.P. to crush medium hard quartz. A single set of jaw plates crushes 55,000 tons (1/9 cent per ton). Even the ball consumption in the mill is reduced (from 2.4 lbs. to 1.9 lbs. per ton).

You can't afford to pass up such increases in profits. Put a Kue-Ken Crusher to work at your mine as soon as possible.

Write for complete data now. Ask for the names of other mine owners who are cashing in with Kue-Ken. There's no obligation. It may mean dollars in your pocket.

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World's Largest Dragline is Equipped 100% with Pan-American Jigs

● The largest dragline operation in the world is Dayton Dredging Company's huge new plant at Dayton, Nevada. And Dayton is using Pan-American Jigs to handle the entire recovery operation.

● The entire jig installation design and assembly was worked out by Pan-American engineers in co-operation with the dredge builders.

● We welcome inquiries as to how Pan-American Jigs can be used profitably on placer operations. Placer Jigs for roughers. Pulsator Jigs for cleaners, or for roughers on small operations.

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PJE and PLE

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Design, Metallurgical Testing and Field Consulting Service; Manufacturers of Mill and Placer Recovery Equipment.

▶MEXICO

City and Acapulco, is being arranged by a recently organized Mexican subsidiary of Bethlehem Steel, it is learned in government circles. Practically all this iron will be exported, it is understood. Exports of this iron could have begun late last year, but Bethlehem refused to accept the loading terms of 10 pesos ($2.20) per ton by the Acapulco stevedores. Plans were made to ship the metal by aerial railway to the port. This proposition could not be consummated, owing to insufficient power. However, this railway will be able to obtain power with the opening, scheduled for some time in July, of a plant near the deposit. This plant is also counted upon to provide ample electricity for exploitation of the iron mines.

▶Cia. Minera de El Tajo, S. A., owned by Americans, has leased its mines at El Rosario, Sinaloa, to its workers for ten years at a monthly rental of 3,000 pesos ($625), according to the national miners union. This transaction is seen as assuring the steady working of these properties, which El Tajo some time ago turned over to its workers to conduct on a cooperative basis.

▶When it demonstrated to the federal labor authorities that its high-grade orebodies are exhausted and operations are unprofitable, Cia Minera La Soledad, S. A., Sabinas Hidalgo, Nuevo Leon, was permitted to discontinue work. The 23 remaining workers were paid compensation of 2,737 pesos ($584), two months salary each, for dismissal.

▶Revision of the labor contract to allow the employees many advantages, at a cost of 130,000 pesos ($26,600) a year to the company, averted a strike at the Santa Barbara unit, Chihuahua, of American Smelting. The outlay is to finance a workers' consumption cooperative society and a medical clinic and increase the compensation for workers who are incapacitated.

▶Cia. Minera Amparo, S. A., Guanajuato City, Guanajuato, James H. Howard, Apartado Postal 19, Guadalajara, Jalisco, general manager, is not going to suspend operations but intends to increase its activities, the company announces. This firm recently agreed to retain all of its some 400 employees and to grant a general wage increase of 6 per cent.

▶Minas Artemisa, S. A., Huepac, Sonora, Oliver O. Kendall, P. O. Box 27, Bisbee, Arizona, president, Frank O. Jasmer, Estacion Poza, Sonora, engineer, expects soon to have greater service for the handling of its concentrates with the opening of a 150-ton lead and zinc smelter near Warren, Ariz. This plant is to handle the company's ore concentrated in Mexico. Installation of the smelter has been delayed because of the preference of war orders over private demands in the United States.

▶The strike at the Monterrey lead refinery of the American Smelting & Refining Company has been settled, it was announced June 16. The plant was shut down March 27. In resuming operations at the property the company will be relieved of treating Mexican bullion in the United States, a more costly operation than that of producing the refined metal at Monterrey.

▶Asarco lost a curious suit, an injunction to set aside orders of the federal board of conciliation and arbitration that it must pay the funeral expenses of a miner who was killed in an accident, when the national supreme court ruled that the federal labor laws make it compulsory for employers to pay these expenses when workers die in mishaps or as a result of them. The ruling establishes a precedent. Asarco contended that as it had paid indemnification for the miner's death it did not consider that it must bury him as well.

▶A steady increase in mercury production is reported by the ministry of national economy. This output jumped from 57,778 kg. last January to 84,313 kg. in February. There was also a marked increase in antimony production, from 772,550 kg. in January to 1,654,888 kg. in February.

SOUTH AMERICA

Large Iron Deposit in Brazil Being Exploited

A loan of $20,000,000 from the Import and Export Bank will permit development and construction of large steel plant near Volta Redonda, State of Rio de Janeiro

▶The mining activities in Brazil have been substantially increased in the last year, notwithstanding some difficulties due to the war. In spite of the stressed growth which occurred, the Brazilian mineral industry is still very small, chiefly when compared with the natural resources of the country, most of which are expecting a convenient exploitation.

▶The most important development announced is the new steel plant to be constructed soon near Volta Redonda, in the State of Rio de Janeiro. The plant will be operated by the Companhia Siderurgica Nacional, partly owned by the Brazilian Government, and is expected to be completed within three years, with a production of 300,000 tons of steel per year. The total cost of the plant is of about $45,000,000. A loan of $20,000,000 has been secured by the Import and Export Bank to the company in order to attend the expenses of the equipment, to be imported from the United States. The plant will treat high-grade iron ores from the State of Minas Geraes, whose reserves are more than ten billion tons. Coke will be used, a small fraction of the consumption being imported from the United States, whereas the rest will be supplied from coal mines in the State of Santa Catarina. More than one million tons of coal would be required, the figure being as high as the actual output of the coal mines in operation in the country.

▶Owing to the war restrictions on shipments, the exports of iron and manganese ores have fallen, the levels being almost the same as in the years before the war. The Sociedade Brasileira de

Mineração Limitada has started the exportation of high-grade manganese ores from the Urucum mine, near Corumba, State of Matto Grosso. Sixty thousand tons are to be delivered by ships of the Lloyd Brasileiro from Corumba to the United States, through Buenos Aires.

▶In Southeastern São Paulo, the new mining district of the Ribeira de Iguape Valley has been the subject of an intensive work during the last eight months. Several mines of lead-silver ores are now in operation, since the Government of the State of São Paulo started the operation of the Apiai smelter. Before that plant started operation on a pilot-plant scale last August, no lead was produced in the country. Regular shipments of hand-picked ores were made some years ago, mostly to European smelters. New furnaces under erection at that plant will increase the capacity to 6,000 tons of refined lead per year. A new mill is producing from old tailings at the Furnas mine, lead-silver concentrates that are being hauled by trucks to the Apiai smelter. The mines known by Panelas, Lageado, and Lourdes are being prospected, and if the conditions will be as favorable as seems probable, a larger output of the district is expected. In the same district, where several gold placers were intensely worked two centuries ago, the Companhia Mineração de Apiai is testing its new 50 tons per day amalgamation and cyanidation mill, treating the ore from the Morro do Ouro mine, in the town of Apiai. Gold mining in other districts, chiefly Minas Geraes and Parana, is steady and no substantial increase of production is reported. The famous Morro Velho mine, operated by the St. John d'El Rey Gold Mining Co., for more than 120 years continuously, is still the country's largest producer.

ARGENTINA

▶The Metals Reserve Co. has purchased 100,000 long tons of zinc concentrate from the Aguilar Corp., operating in the Argentine. St. Joseph Lead Co. owns 89 percent of the stock of the Argentine lead-zinc producer. The concentrate, now stored in the Argentine, formerly was shipped to European smelters. The concentrate contains about 42,500 tons of zinc.

Molybdenum Deposit in San Salvador

▶A deposit of molybdenum, 8 km. east of the village of Teputla, State of Chalatenango, Republic of San Salvador, has been found. The road to the prospect is reported good for about 3 km., with the remainder of the distance having to be made on horseback. La Toma, 40 km. away, is the nearest railway point where the government is completing a new highway this year, to the Hondurian frontier. Surface prospecting has revealed the vein in a 30-ft. shaft to average between 4 and 5 ft., and samples of the ore show from 8½ per cent to 19 per cent MoS_2. The property is owned by Señor Pablo Oertel, San Salvador, Central America.

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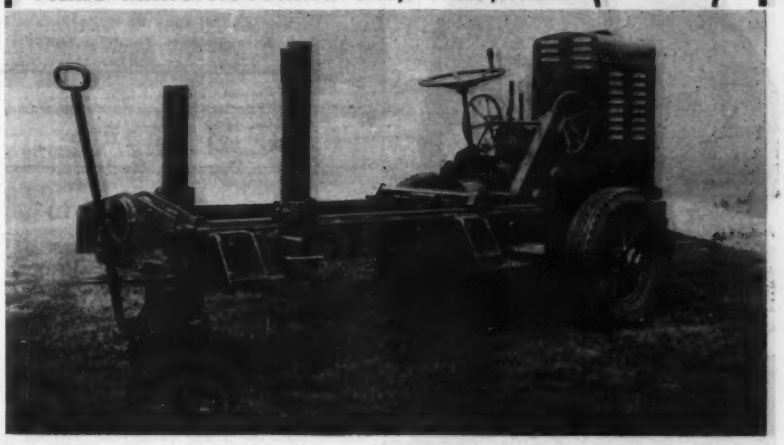

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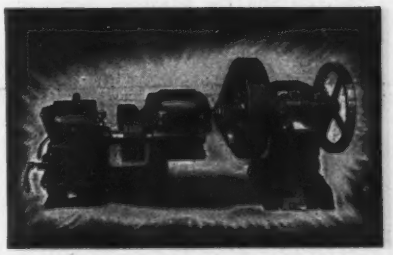

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CANADA

Activity Continues in Northwest Territories

Tungsten concentrates being produced near Great Slave Lake—Gold output in Quebec Province shows substantial increase this year

▶ In the Yellowknife River area, north of Great Slave Lake, about 600 men are employed by the three producing mines and the three properties that are in the development stage. The Con started production in August, 1938, and is now treating 160 tons daily, but is to increase capacity to 350 tons this summer. So far all mill feed has come from above the 1,000-ft. horizon. Both the Con and the adjoining Negus are controlled by Consolidated Smelters, the Negus going into production in February, 1939, with a 60-ton mill. The Negus shaft, now at 500 ft., is being deepened to 675. Combined output from both mines amounts to more than $5,000,000.

▶ Thompson-Lundmark Gold Mines, 35 miles northeast of the town of Yellowknife, was discovered in 1938 by the well-known Rouyn prospector, Fred W. Thompson. Diamond drilling and underground work on two main zones indicated ore valued at $1,500,000. A 150-ton Hadsell mill is now installed and production is expected to start soon. Last summer Smelters took over the property and advanced $350,000 to finance production.

▶ Consolidated Mining & Smelting also controls the Ptarmigan mine, 8 miles northeast of Yellowknife. Last month it was decided to start mill construction, the probable initial capacity to be 100 tons. Indicated ore exceeds $1,500,000, exploration being by means of a 900-ft. shaft.

▶ Slave Lake Gold Mines, located on a group of small islands at the east end of Great Slave Lake, started operating a 50-ton mill last winter. In addition to gold recovery, tungsten concentrates are made.

QUEBEC

▶ Gold production in Quebec increased 7.5 percent in the first four months of this year, with 358,153 oz., compared with 332,927 oz. in the same period of 1940, according to a statement by the Quebec Bureau of Mines. An all-time record was made in March with 92,843 oz. There was a 39 percent increase in

No. 4 shaft of the Sylvanite Gold Mines, Ltd., looking east toward the Toburn Gold Mines, Ltd., which also operates in this Ontario mining district

silver, amounting to 538,324 oz. in the first four months. Clay products increased 87 percent, with a value of $454,833. Lime production was 89,572 tons, up 33 percent, and cement output was up 24 percent, to 684,552 barrels. Copper and zinc production also had a marked increase, but figures are not to be published for the duration of the war.

▶ Belleterre Quebec Mines has jumped into prominence with an average recovery of $17.07 for the first quarter of the year, against the average of $10.15 for the first three months of 1940. The province's highest grade producer, the mine now holds fifth place in bullion output as a result of steady mill enlargement to the present average of 344 tons daily. Only Lamaque, Sigma, East Malartic, and Beattie now rank above Belleterre in gross output. Located 50 miles south of the Rouyn-Kirkland Lake gold belt, the Guillet (Mud) Lake district was first opened in 1934. McIntyre Porcupine optioned a good showing and established a record by having the property in production within two years. In 1939 the discovery of two new vein systems led to spectacular expansion in the mine program that is now assuming an air of permanence, with the building of a hospital and laying out a townsite where some 30 houses are to be built.

▶ Powell Rouyn Gold Mines has found values in the south shaft considerably higher than the $3 average that had been indicated by diamond drilling. The average grade from one stope mined in the last week of May was $4.88. Development work has disclosed other values that had been missed by drill holes, and a large block of favorable ground remains to be explored above the 1,500-ft. horizon. Stope preparation below the 800 level shows short oreshoots that have better width and grade than was anticipated. Although a steadily rising grade is expected over the next few months, complete control of grade is impossible with the mining methods now in use. The new 450-ton mill is operating efficiently and an additional 400 tons a day of flux ore is shipped to the Noranda smelter. Backfilling is being started, using material available close to the shaft. W. E. Leonard is mine manager.

▶ Aldermac Copper Corp. is developing the new ninth and tenth levels and driving west on the eighth level at 1,125 ft., in preparation for deep drill exploration of a favorable geological area. The main No. 4 orebody has been showing less promise at depth. An average copper content of 1.75 percent makes it possible for the 1,000-ton mill to show a profit only because of extremely low costs, plus the revenue from sales of pyrite. Col. C. D. H. MacAlpine is president and A. V. Corlett mine manager.

▶ Amphi Gold Syndicate has extended its option agreement with Howey Gold Mines and associates to October, 1942. Diamond drilling on the east group, north of Sladen and Canadian Malartic, has shown promise. Excellent ore intersections have been secured in a wide shear zone and underground exploration is required to determine whether continuity exists. George Salton is supervising work.

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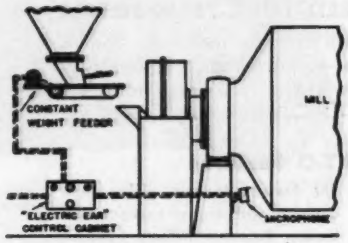

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▶CANADA

▶Cournor Mining Co., operating south of the Perron, has discovered a strong vein 4.3 ft. wide and assaying 0.14 oz. a ton, south of the 696 structure. The 687-689 vein has been opened for a length of 340 ft. averaging better than drift width. Another 4-ft. vein was located in raising up from the 688 ore structure. Dr. F. C. Buckland is manager.

BRITISH COLUMBIA

▶Kootenay Belle Gold Mines, Ltd. (Nelson district), reports production of 12,063 oz. gold and 3,258 oz. silver, valued at $465,656, from 37,130 tons, averaging $12.54 for the fiscal year ended Feb. 28, 1941. This compares with 18,219 oz. gold, and 5,224 oz. silver, valued at $673,420 from 51,844 tons averaging $12.99, in the previous fiscal year.

▶The annual report of Gold Belt Mining Co., Ltd., for the fiscal year ended March 31, 1941, shows that this Nelson district operator produced 16,686 oz. gold and 6,989 oz. silver, valued at $644,989, from 62,037 tons of ore milled. Average recovery was 0.269 oz. gold per ton. H. Grattan Lynch, manager, estimated the ore reserves at the end of the fiscal year at 35,930 tons of ore blocked and broken, having an average grade of 0.31 oz. gold per ton.

▶Hedley Mascot Gold Mines, Ltd. (Osoyoos district), produced 22,818 oz. gold, valued at $864,670, from 62,812 tons, averaging 0.386 oz. gold per ton, in the fiscal year ending Dec. 31, 1940. The lower section of the mine is now responsible for 50 percent of the ore. Development for the year amounted to 17,070 ft. of diamond drilling, 2,306 ft. of drifting, and 1,788 ft. of raising. The mine operated regularly throughout the year on a 175 tons per day basis.

▶The annual report of Big Missouri Mines Corp., for the year ended Jan. 31, 1941, shows that an operating profit of $6,805 was made, after provision of $21,459 for future development and $21,211 for stope preparation. An average of 639 tons of ore was milled daily exclusive of the shutdown period for a total of 212,112 tons, averaging 0.068 oz. gold per ton.

▶Spud Valley Gold Mines, Ltd., Zeballos producer, is enlarging its mill to handle the ore from the newly acquired North Star property, which is expected to offset the steady reduction of recent months. Equipment for the new ball mill, which will increase capacity by 100 percent, is now at the property.

▶The California mine, in the Nelson district, has been selected by the B. C. Department of Mines as the first idle property on which to apply its recently announced program of assistance to small or idle properties with a view to bringing them into production. The California has been leased and work has commenced under the direction of R. J. Maconachie, resident mining engineer at Nelson.

AUSTRALIA

Deep Lead Mining for Tin in Tasmania

Briseis Consolidated, N. L., maintaining interesting operation for recovery placer of tin beneath basalt overburden

▶Briseis Consolidated, N. L., is the largest tin producer in the Australian Commonwealth. At the company's mine at Derby, 60 miles east of Launceston, in the north of the island, a large deep lead is being worked by hydraulic sluicing. The tin-bearing wash has a depth of 250 ft. and is covered by 150 ft. of basalt, which was subsequently cut through by the Ringarooma River. In order to work the wash it was necessary to divert the river. This has been done three times. No further diversions will be needed and the river now flows in its new course, 150 ft. above the bottom of the cut, by a bed and bank of tailings. The water for working the deposit is brought to the nozzles by extensive races, the maximum head between penstock and nozzle being 400 ft.

Mining alluvial tin in Kuala Lumpor, Federated Malay States, is improved over the hand methods by use of a LeTourneau anglebody and Caterpillar tractor equipped with a silencer because of a hospital near by

The wash is lifted from the bottom of the cut by hydraulic elevators delivering to two 16-in. electrically driven gravel pumps in series, each with a vertical lift of 110 ft., discharging to the sluice boxes. The basalt overburden is undercut by the nozzle, broken in falling and reduced to 20-in. size by "blistering," and is sluiced away through a special overburden tunnel.

WESTERN AUSTRALIA

The mine of Sons of Gwalia, Ltd., near Leonora, 150 miles north of Kalgoorlie, is one of the deepest and most important in the State. During 1940, 154,772 tons of ore treated produced 44,512 oz. of gold and 406 men were employed. Work was hampered to some extent by a shortage of labor. During the year 4,287 ft. of development work was carried out and the internal shaft, to work the lode below No. 30 level, has been commenced.

▶South Kalgurli Consolidated, Ltd., at Kalgoorlie, earned a profit of £Stg. 27,923 from mining operations and £2,537 from other sources, making a total profit for the year to March 31, 1940, £Stg. 30,460. Distributions to shareholders amounted to £31,251. Ore treated during the year amounted to 118.794 short tons, of which 99,946 tons came from the company's mine and 18,848 tons was purchased. At South Kalgurli the ore is ground dry in ball mills, roasted in Edwards and Merton furnaces, thickened, agitated, and cyanided. Filter presses and Merrill-Crowe precipitation are included in the plant. Costs are higher than in the modern plants, but the recovery of gold is better by several per cent.

▶Gold Mines of Kalgoorlie, Ltd., was formed in 1934 to develop and operate a group of twelve abandoned leases on the Golden Mile, Kalgoorlie. Operations have shown a steady expansion, ore reserves have continued to increase, and the year ended March 31 has shown a marked improvement in output over the record for the previous year

QUEENSLAND

▶No organization in Australia has such widespread activities as the Broken Hill Proprietary Co., Ltd. In addition to the great iron and steel industry and its many subsidiaries, the company is widely interested in the production of gold and is devoting considerable attention to tin mining. On Battle and Nettle creeks, near Mount Garnet, in North Queensland, boring and testing operations have been carried out for many months. This work is now completed and it is expected that a dredge will be constructed and a water supply provided at an approximate cost of £A300,000. The boring plant has been removed to the Kangaroo Hills tin field, where an alluvial area on the Rocky River is to be tested.

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▶AUSTRALIA

the diamond-drill bore from the end of the crosscut from the main shaft has entered the lode at a distance of 151 ft. and is now proceeding in ore. This is the deepest horizon at which ore has been located in the mine during development.

AFRICA

Huge Gold Output Continues on Rand

Production being maintained above one million ounces monthly—Supplies for new mill for Vlakfontein Gold Mining Co. arriving in good order

▶Witwatersrand's gold production is continuing to increase at a rate that is wellnigh sensational. The April output of the district, with the other small producers of the Transvaal included, was 1,166,456 oz. This was 33,020 oz. less than in March, but the daily rate of production for the 30 days of April was 38,949 oz., so one day more would have carried it above 1,200,000 oz. Several of the mines made new high records of output in April. Annual reports now coming to hand show that profits for the past year were in many cases new high records for all time. Although some of the European employees have joined the fighting services, the supply of native labor is large. Because of the common feeling that each must make a personal contribution to the war effort, the efficiency of labor is high. There has been no increase of working costs which call for mention, and profits, before taxation, have made great gains. For instance, the combined working profits of the six producers in the Anglo-American group was up £2,633,641 at £9,587,744; in other groups Durban Roodepoort's profit was up £502,141, Robinson Deep's £217,330, and Modder B's was £143,946 higher. Crown Mines earned £1,200,425 more, and there were many other striking increases.

▶Other Crown Mines figures than those showing the immense increase of earnings are too interesting not to be mentioned. Tonnage of ore milled was up 139,000 to a total of 4,168,000 tons, a scale of operations which compares almost with that of the big copper-mining companies. Developed ore reserves were reduced by 1,024,500 tons, but this left the total remaining at 25,019,700 tons averaging 5 dwt. per ton. Dividends last year came to 185 percent, against 190 percent in 1939. Taxation absorbed £2,046,030 of the year's profits of £8,508,455. The previous year taxes took only £1,229,902, so the increase in this item was over 66 percent.

▶The increases of profits are interesting, but vital chiefly to the government, nearly all of them—in some cases more than all—being absorbed by taxation. New producers which have largely increased their outputs and profits during the past few years are most heavily hit by the taxation. Witwatersrand Deep, for instance, increased its profits by £73,819 and taxation by £58,456. The profit of West Rand Consolidated Mines was up £511,383 and its taxes by £451,903. South African Land's profit at £1,684,471 was almost doubled, but its taxes were up from £112,356 to £795,879.

▶But some relief for companies with wasting assets, chief of which are mines, is being arranged for by the British Government, which purposes to make allowances from April 1, 1940. It also intends to return when the war ends 20 percent of the excess income taxes and National Defence Contribution which may have been paid during the war. When the details are worked out there will perhaps be special allowances for the newer gold producers and such other mines as Mufulira Copper, which the 100 percent excess profits tax has punished too severely.

▶Vlakfontein Gold Mining Co.'s new milling plant of 20,000 tons' monthly capacity is making good progress towards completion. Nearly all the materials and equipment from overseas has arrived and if there is no unexpected delay in receipt of the remainder, milling should begin early next year. Development in the mine is declared officially to be "satisfactory, especially as regards the average value and payable footage disclosed, though the percentage of payability is admittedly somewhat on the low side and the reef narrower than was originally anticipated." Values like 42.9 dwt., 34.8 dwt., and 29.7 dwt. over widths of 9.4 to 9.9 in. are most common. Extensions of Sub Nigel shoots are expected to be encountered later.

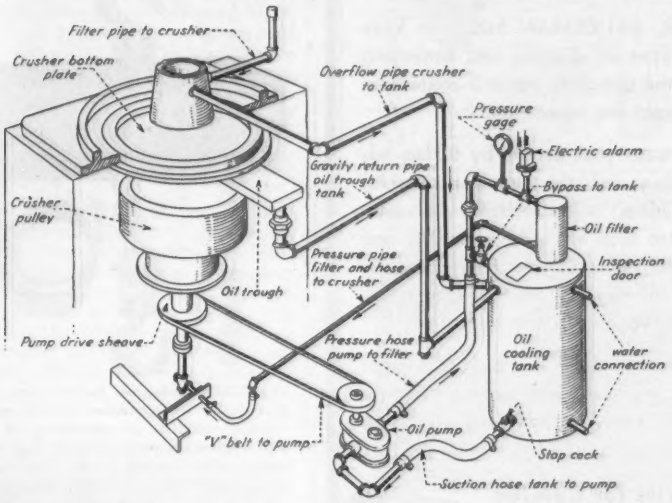
▶Spring Mines and West Springs plan to sink a joint shaft near their common boundary. It will cost about £1,000,000, of which Spring Mines will contribute two-thirds. The shaft is needed chiefly for ventilation, due to Spring Mines opening its southern areas and West Springs developing in the Vlakfontein area. The expenditure "possibly from profits" will be spread over five years.

▶Luiri Gold Areas has called a meeting to consider placing the company in liquidation, having failed to obtain further financing.

▶DeBeers Consolidated Mines, the premier diamond producer, has paid a final dividend of £1 per share on its 40 percent cumulative preference shares, this clearing off the six months' arrears. All unproductive work has been discontinued at the mine and the plant has been remodeled to increase its efficiency. For some months past sales of diamonds have been showing a distinct improvement. Sales of uncut stones have been running at the rate of $1,000,000 a month, this being possible because much of the diamond-cutting equipment and some of the diamond cutters escaped from Holland to Britain when Holland was invaded. There has been increased demand for industrial diamonds also. The United States has been a large buyer of gem stones. Consolidated African Selection Trust is understood to be sold out up to the minute. The diamond business is thus prosperous again, and its prosperity promises to increase as additions are made to the force of diamond cutters.

EQUIPMENT NEWS

Improved Pressure Type Oiling System for Gyratory Crushers



KENNEDY VAN SAUN Mfg. & Eng. Corp., 2 Park Ave., New York, N. Y., has recently adapted a new oiling system for its gyratory crushers. The isometric sketch shows general arrangement of the oiling system. The oil pump is arranged for V-belt drive from crusher, and is located below the external tank, so that the pump is always primed. From the pump the oil goes to a filter, then through the filter and pressure line to the crusher. The oil is delivered under pressure to the crusher through a stuffing box which provides a seal and prevents leakage. Thus clean, cooled oil is said to be delivered to crusher bearing under pressure to lubricate all working surfaces positively. Oil enters the crusher at the bottom of the shaft under pressure and is forced up through the bearing surface between the main shaft and the ball for eccentric, then spills out over the top of the ball and returns through the eccentric to the chamber in the bottom driving disk. From here it is taken up by capillary action to the circular oil trough, and returned by gravity to the external oil cooling tank. The diaphragm sleeve chamber of the bottom plate is fitted with an overflow pipe so that in case the oil reaches above the top of the eccentric, this excess oil will automatically drain back by gravity to the external oil cooling tank. A bypass is provided in the pressure line between the pump and filter, so oil flow may be partially bypassed to external tank if it is desired to reduce oil flow delivered to the crusher.

In the pressure line between pump and filter, a gage indicates the pressure at which oil is being delivered by the pump to the filter and crusher. In addition, an electric oil-pressure switch is installed in the line from the pump, so that if the oil pressure is below a certain predetermined pressure, the switch actuates an industrial howler, sounding an audible alarm warning the operator.

Another feature of the new lubricating system is said to be the use of flexible hose for a portion of the piping arrangement, which facilitates and simplifies installation.

Pneumatic Impact Roller For Conveyors

A RECENT DEVELOPMENT in the materials-handling field is the pneumatic roller, for carriers on belt conveyors, wherever the shocks of impact are excessive. It is introduced by the Stephens-Adamson Manufacturing Co., Aurora, Ill. These pneumatic carriers are specially designed for use under loading spouts and in belt feeders where the impact of heavy bulk loads subjects both conveyor belt and carrier to abnormal strains and wear. To cushion the impact of materials (and thereby prolong conveyor belt life), the rollers in these carriers are made up of a series of pneumatic rubber units, 6 in. in diameter, suggestive of miniature automobile tires. Their advantage over a solid roller has been compared to the advantage of the pneumatic tire for trucks and automobiles over the now obsolete solid rubber tire: greater resiliency to shock and impact and increased life.

Brazing Alloy

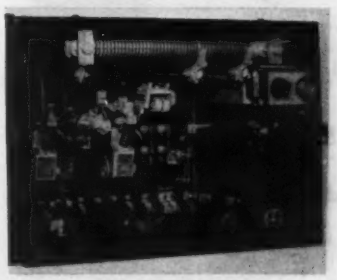
HANDY AND HARMAN, 82 Fulton St., New York, N. Y., announces its Easy-Flo, a medium silver alloy flowing freely at 1,175 deg. F. for quick brazing of broken machine parts. The pictures illustrate an application of this alloy. A special 1⅝-in. tap was broken in a plant and quick replacement was difficult. The broken parts were cleaned and fluxed with a low-temperature flux and held together in a milling machine vise. Heating was done with an oxyacetylene torch and the brazing alloy used to join the parts. Brazing time was ½ hour and the tap was back in service in four hours.

The ten broken pieces that had to be brazed

The fine white lines in the shank indicate where the various parts were joined

Combination Starter

REMOTE AND AUTOMATIC CONTROL for mining equipment such as conveyors, pumps, fans, etc., is provided in the new d-c combination starter announced by Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Automatic starting and acceleration are accomplished from a built-in or remotely mounted pushbutton. Safety features include a line-disconnecting switch, low voltage protection, combination thermal, instantaneous overload protection, and safety interlocks to prevent opening the door unless the switch is off. When the



disconnecting switch is closed and the start button pushed, the line contactor closes, starting the motor with resistance in the circuit. The coil of the accelerating contactor is connected across the motor armature. As the motor accelerates, the voltage across the armature increases and causes the accelerating contactor to close at the proper time. This

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Pictured above is a 2 cu. yd. Sauerman Drag Scraper with self-propelled head tower that handles a large stockpile of silica sand at a plate glass factory. A reserve supply of sand is piled up by the scraper during the summer on a 300' x 500' ground area. During the winter, when incoming shipments of sand are cut off, the scraper turns around and reclaims from the stockpile at the rate of 40 tons per hour.

Increase your profits by taking advantage of the many economies available with SAUERMAN Machines such as: wide versatility and speed, one-man operation, extremely low power and maintenance costs, and reliable, steady operation.

These machines are built in a wide range of sizes with capacities up to 1,000 tons per hour and operating spans up to 1500 ft.

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short circuits the resistor and connects the motor across the line. When an accurate definite motor speed is desired, a small adjustable field rheostat may be added which is said to provide up to 15 percent increase in speed.

The Chisholm-Moore Hoist Corp., Tonawanda, N. Y., announces a 1-ton capacity "Comet" hoist as an addition to its line of light-weight, portable, plug-in type electric hoists. Five models of the hoist now include capacities of 250, 500, 750, 1,000, and 2,000 lb.

A Respirator-Goggle

A NEW GOGGLE, designed by Bausch & Lomb, provides complete eyesight protection for workmen engaged in operations where respirators must be used, but where the hazard is not great enough to require a complete helmet.

This metal-frame spectacle goggle is cut away in the nasal portion so that it fits close to the face, yet is said to leave sufficient room for the respirator. The special lens shape is said to have

solved the problem of providing eyesight protection where respirators are used. The construction provides a light-weight, rigid frame and is supplied in a variety of sizes. This goggle is offered with wire mesh or with either clear or green acetate nose and side shields. The nose shields provide extra protection from splashes and flying objects coming from in front of the workman.

New Type Metallizing Gun

A NEW TYPE Metco metallizing gun—type 2E is announced by Rickard & Co., Inc., 330 West 42 St., New York, N. Y., for use in the restoration of worn machine parts of all kinds, such as bearing surfaces, rolls, shafts, pump rods, press fits, repairing defects in castings, etc., with carbon steels, stainless steels, bronze, brass, monel metal, nickel, and other metals. It is also widely used for the application of corrosion-resistant coat-

ings of zinc, aluminum, lead, tin, and other metals, to all types of equipmnet ranging from nuts and bolts to steel bridges, water tanks, and ships. Aluminum coatings have proved successful in retarding heat corrosion or oxidation on exhaust manifolds, furnace parts, and similar equipment.

Metal wire is automatically fed into the gun at an adjustable speed, where it is melted by means of concentrated flame, atomized by compressed air, and sprayed on any base material. The gun may be used as a hand tool for coating large structures with zinc, aluminum, lead, or other metals, or as a lathe tool for building up worn shafts, rolls, plungers, etc., with steel, stainless steel, monel metal, bronze, or any other metal obtainable in wire form.

Features of the Type 2E gun are said to be "Controlled-Power Unit," which gives a uniform and steady wire feed for production service and eliminates the need for gear changes, and the "Universal Gas Head" allows the use of acetylene, propane, hydrogen, natural, or manufactured gas with balanced pressures and without changing heads.

Integral dump boxes permit loading of material and transporting it to discharge points around a smelter by the above-shown industrial truck unit of the Elwell-Parker Electric Co, Cleveland Ohio. Truck mechanism accessible from operator's position elevates dump box to desired height and tilts for clean dumping.

Ohio Brass Co., Mansfield, Ohio, announces development of a new trailing cable connection plug for 80-amp. loads. The new plug, designated as the 80-amp. Mechano-Plug, accommodates a three-conductor cable of No. 6 or smaller sizes of wire.

Colloidal Graphite

RAPIDLY SPREADING USE of colloidal graphite for the lubrication of steam cylinders, air compressors, and similar equipment has led to the issuance of general recommendations by Acheson Colloids Corp., Port Huron, Mich., on the preparation and use of such lubricants. Prime reason for the use of colloidal graphite for this purpose is that this lubricant does not break down under

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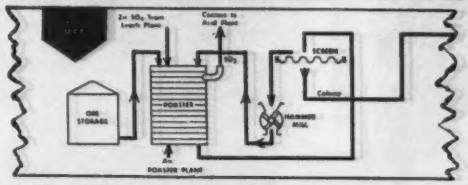

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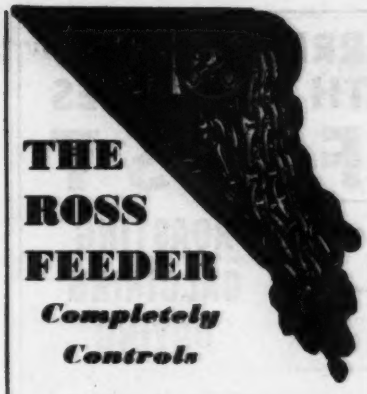

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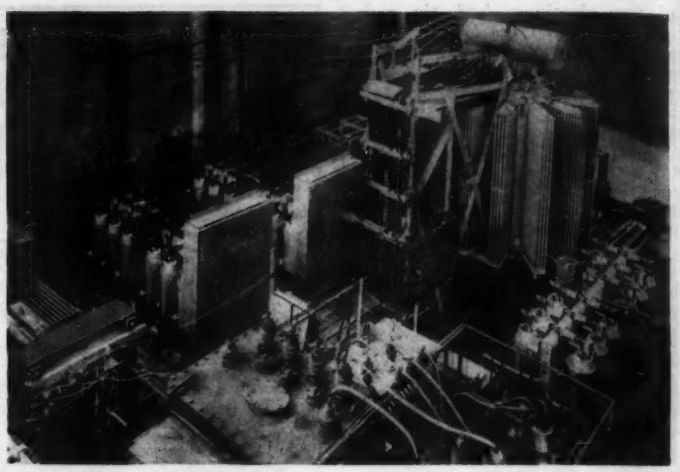

The above is one of six large mercury-arc rectifier units built by General Electric Co., Schenectady, N. Y., for electro-chemical service in the new reduction plant of the Aluminum Company of America now operating at Vancouver, Wash. Rated 10,000 amp., 600 v. d-c, the complete unit comprise two 12-anode ignitron rectifiers with firing cubicle (shown left of center); a main rectifier transformer (upper right); and two all-welded aluminum-bar air-core reactors (lower left)

high temperatures and in the presence of steam.

When lubrication technique is correct, the extremely fine graphite particles form a film of "solid lubricant" (a graphoid surface) on the metal surfaces, minimizing metal-to-metal contact and thus reducing wear on cylinder liners and other friction surfaces.

Since colloidal graphite has unusually high wetting properties, the use of such material in steam cylinder oils, etc., has the effect, also, of protecting against the occurrence of dry spots by speeding up and increasing the spread of oil on surfaces requiring lubrication. In addition, the graphoid film is said to have a higher load-carrying capacity than an equivalent film of oil, particularly at the elevated temperatures encountered.

BULLETINS

Steel Balls. Hadfields, Ltd., Sheffield, England. Bulletin 443 describes the manufacturer's hard forged steel balls for ball and tube mills. Pp. 2.

Crushers. Nordberg Mfg. Co., Milwaukee, Wis. The company announces a small pocket booklet designed as a handy reference for operators of Symons cone crushers. Pp. 12.

Cables. John A. Roebling's Sons Co., Trenton, N. J. Catalog J-862 describes and illustrates the manufacturer's metallic and non-metallic cables for surface or underground use. Pp. 16.

Shaking Screens. Hendrick Mfg. Co., Carbondale, Pa. Booklet describes the manufacturer's new screen that has both a shaking and whipping action. Pp. 8.

Fire Brick. A. P. Green Fire Brick Co., Mexico, Mo. The company offers a handsome brochure illustrating and describing its manufacture of fire brick for industrial uses. Pp. 15.

Continuous Vacuum Filters. The Eimco Corp., Salt Lake City, Utah. Bulletin 404 describes and illustrates the manufacturer's continuous vacuum filters for metallurgical and other industrial uses. The brochure is handsomely illustrated with installation photographs and diagramatic drawings showing relative elevation arrangements of the filters and accessory equipment. Pp. 48.

Flotation Cells. Denver Equipment Co., Denver, Colo. Bulletin F-11-B is an attractive brochure describing and illustrating the manufacturer's "Sub. A" flotation machines. Pp. 17.

Safe Sling Practice. Macwhyte Co., Kenosha, Wis. The company has issued an attractive lealet entitled "Safe Sling Practice" for general industrial use. Pp. 8.

Laboratory Machines. Sturtevant Milling Co., Boston, Mass. Bulletin 067 describes and illustrates the manufacturer's line of laboratory crushers, rolls, sample grinders, and swing-sledge mills. Pp. 11.

Structural Design of Refractory Concrete. The Atlas Lumnite Cement Co., 135 E. 42nd St., New York City. The company has issued an illustrated booklet with charts and sketches describing methods of building industrial furnaces and kilns, with reinforced refractory concrete. Pp. 18.

Vibrating Screens. Jeffrey Manufacturing Co., Columbus, Ohio. Bulletin 757 describes and illustrates the manufacturer's line of electric vibrating screens for various industrial uses. Pp. 5. **Car Puller.** Folder 712-A describes the company's all-purpose car puller for mines, power plants and other industrial applications.

Air-Powered Tools. Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago. Catalog 42 describes the complete line of Thor mining and contractor's air-power tools manufactured by the company. The brochure is well illustrated and contains detailed information on accessories and equipment for use with the tools, pointing out important construction features. Pp. 64.

Centrifugal Blowers. Roots-Connersville Blower Corp., Connersville, Ind. Bulletin G-70 describes and illustrates the complete line of the manufacturer's positive displacement blowers, gas exhausters and boosters, centrifugal blowers and exhausters, and inert gas generators. A brief summary of the applications for which each type of equipment is suited is also included.

Transformers. Moloney Electric Co., St. Louis, Mo. Bulletin D-412 describes and illustrates features of the company's Type KL and Type CL distribution transformers. Pp. 4.

Rail Punches. Gibralter Equipment & Mfg. Co., St. Louis, Mo. The company has issued a catalog describing its rail punches, shop punches, key-seating machines, and grease guns for use in mines and other industrial applications. Pp. 8.

MBI Patented Sink-and-Float process of concentrating ore is the subject of an attractive brochure issued by the American Zinc, Lead & Smelting Co., Paul Brown Bldg., St. Louis, Mo. The process is de-